AFTER THE FLUSH

GARBAGE

The Practical Journal for the Environment

JAN/FEB 90

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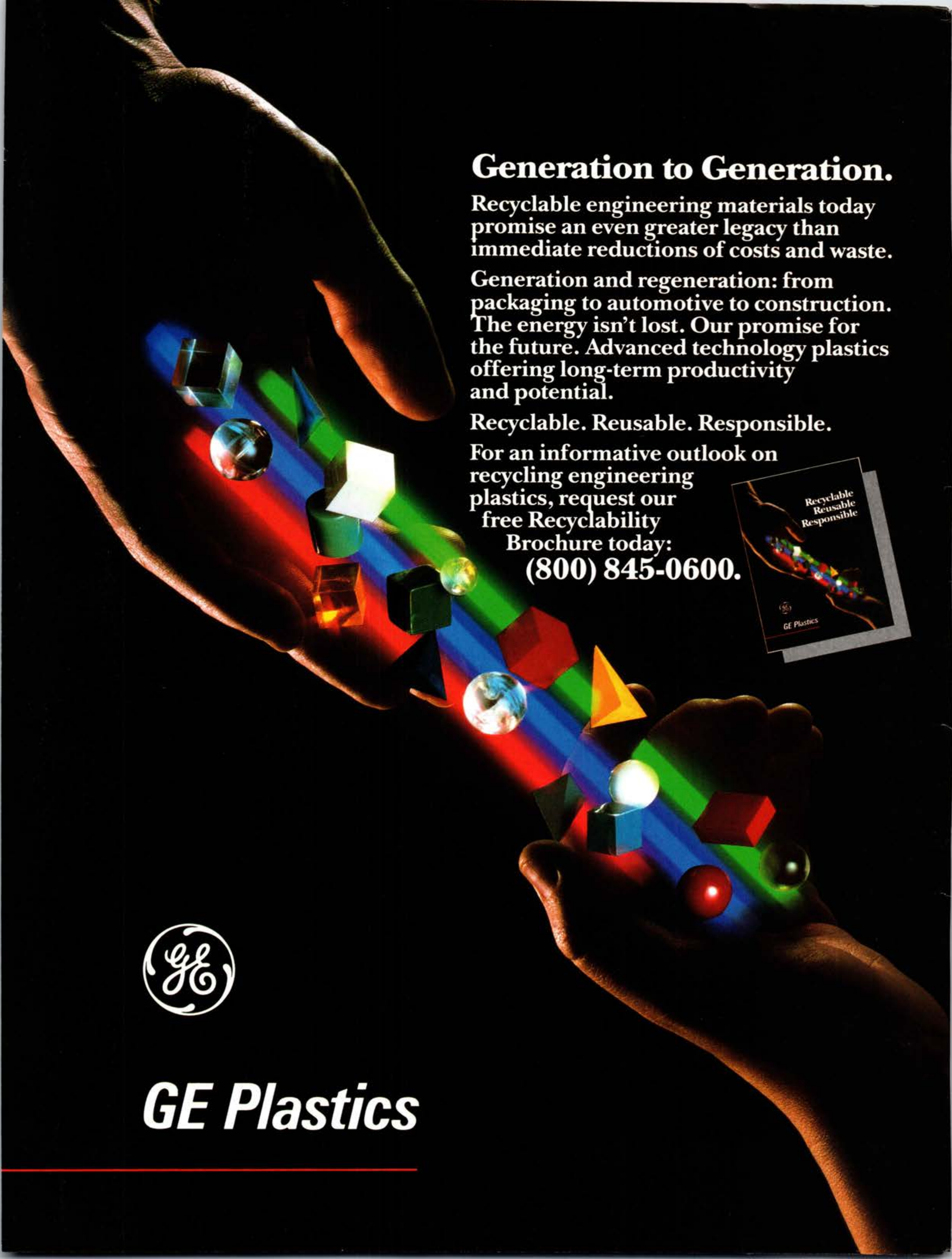

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AFTER THE FLUSH

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Cover photo by Donald Betts, Horizon Photographics, Inc. Toilet courtesy of Urban Archeology, New York, N.Y. Tidal pool photo, Gloucester, Mass., by Patricia Poore

FROM THE EDITOR

Producing waste is an inescapable fact of life. Industrial societies produce a staggering amount. Yet, considering how much waste we produce, and considering how many wasteful habits we've developed, it's remarkable how little attention we pay to it. Most people have no idea what happens to their garbage or their body waste: put it at the curb and somebody takes it, flush the toilet and it disappears. We don't like to talk about it, because that's considered rude, disgusting, unnatural, or dirty. Sounds almost like a taboo....

A magazine tends to take on a life of its own. Every once in a while you stand back and take a look – to make sure it's accomplishing its mission, and to see what unpredictable twists and turns it's taken.

As we finished this issue of **GARBAGE**, I stood back. And I realized with some awe that one of the sub-plots is that we're butting heads with American taboos. That's risky. But do we have a choice?

Years of ignoring the subject of waste is precisely what has led to our environmental crisis. It's as if we silently agreed to sweep it under the rug at a time when the rug seemed limitless. Then we found out the rug was not as big as we thought; stuff was oozing out around the edges. We can't ignore it anymore, and that means we're going to have to face the taboos.

It's happening more easily than I'd have thought. When we first named the magazine **GARBAGE**, we met tremendous resistance. For example, our editors had already been making calls to sources and potential authors, identifying themselves as "from the Old-House Journal; we're starting a new magazine on the environment." People were friendly and encouraging. Then we named it: "Hello, I'm an editor at **GARBAGE** magazine..." and suddenly some of them wouldn't talk to us. Environmentalists were among the most vocal (magazine consultants ran a close second) in condemning the name.

It's not as if we were asking these people to invest... so what if we wanted to take a risk? Why such resistance? I think it's that word "taboo" again. Nobody wants to talk about the yucky stuff. Worse, everybody assumes that "the public" can't deal with the yucky stuff.

We kept our blunt name anyway, and people got used to it. There's almost unanimous acceptance of it now, partly because it's become apparent that **GARBAGE** isn't a spoof, isn't strident or offensive. But it's also because (unconsciously) we timed it well. In the past year, garbage has become a chic topic, almost as if, collectively, we decided to face it. And realized that it felt better than ignoring it.

I'm relieved that our gamble paid off, but I never lost faith that it would. Why shouldn't people be interested? After all, everybody makes garbage.

Well, now that trash is practically a polite subject, we've taken on the other great taboo. If we had a board of directors, we may not have gotten a consensus on the wisdom of putting a flying commode on the cover, or writing about toilets, sewage, and diapers all in the same issue.

But we're confident that people really do want to know about these things. For us editors, this has been the most satisfying issue yet. We watched our own attitudes evolve in the process of putting it together. Starting out, we had a hands-off approach and a lot of worry about how we were going to make this palatable (so to speak), not to mention illustrate it. Then, as articles took shape and our understanding grew, we found ourselves at ease with the subject and honestly fascinated with the possibilities of water conservation, the necessity of toilet redesign, the stupidity of large-scale sewage treatment as it exists today. Through it all, of course, the scatological puns and jokes flew around the office. (It's very helpful to act infantile when confronting a taboo.)

But we spared you most of that (resisting the impulse to call this issue "the scoop on poop"). Instead, you'll find a clear explanation of just what happens after you flush; you'll find good science and necessary controversy, practical suggestions and a call for changes that can only be legislated. Go ahead, read it, it's surprisingly interesting.

After all, everybody ... (you know).

Patricia Poore

In the next issue of
GARBAGE

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Household Hazardous Waste

Controlling Pests Without Chemical Warfare

Plants as Air Filters

"Better Living Through Chemicals"

GARBAGE
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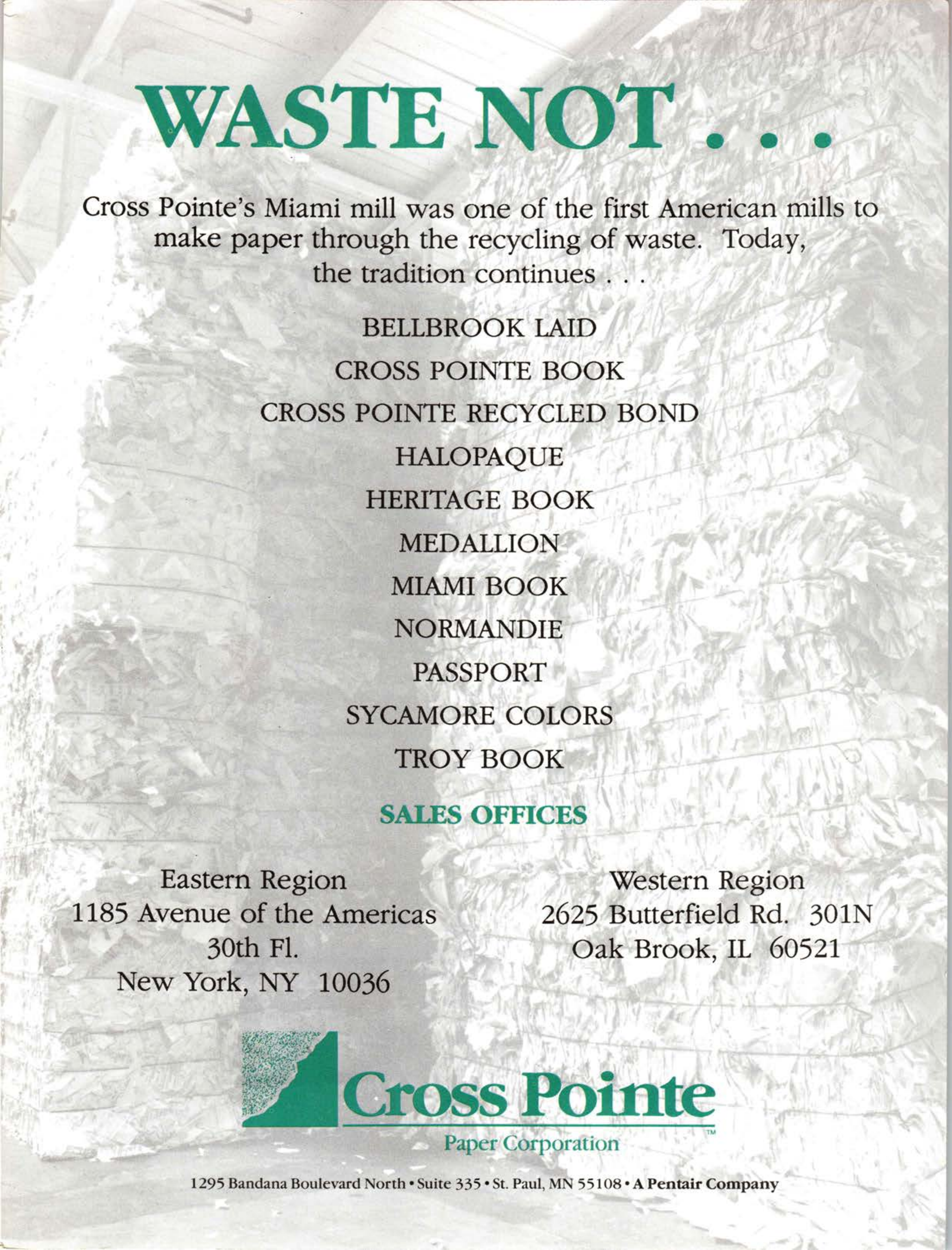

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Your magazine is devoted entirely to our relationship with the environment and it emphasizes that each of us has a part in caring for that environment.

The problem is that your new glossy magazine is not recyclable. In your subscription letter you say the magazine "doesn't beat around the bush, but goes right to the heart of the problem: our throwaway society." It seems to me that your nonrecyclable magazine is contributing to the problem of a throwaway society. As one of the first magazines devoted to the problem of garbage and recycling, I think it would be important to set an example for your readers.

Scott J. Jaeger
Stevens Point, Wis.

All magazine-grade paper, including glossy, is now recyclable, although it's true that the clay used in coating creates sludge in repulping. GARBAGE is printed on Cross Pointe's Troy Book stock, recycled and *recyclable. It has no clay coating.*
— the editors

Getting Involved

I have a thought. If the clamshell burger container is a major polluter, couldn't we all request that the burger we order to eat in the MacDonalds be served without the clamshell? Maybe we could go to the store with our own reusable clamshells for carry-out.

Keep the answers and problems simple so I can attack them myself and do what I can personally. I can't affect the sludge on the bottom of Boston Harbor, but I can put out a smaller bag of trash for the garbage truck in Indianapolis.

Andrew Buckner
Indianapolis, Ind.

About "In the Dumpster": How about providing a name and address for the company so that we can send them the remains of their product. That way it *will* be in their bottom line, and will make a strong visual statement. Of course a letter explaining our actions would be mandatory, reminding them that the rest of their product line will be passed over on the grocery aisle, too. (Until the offending package is terminated.)

Mighk Wilson
Orlando, Fla.

If you pass it over, how can you send the remains? — the editors

At every daily turn we have difficult choices. The other day I used oil-based paints and, for the first time, thought about the solvent-based paint residues left on the cleaning rags, newspapers, and in the glass jars in which we allow thinners to settle out. We use the settled, clear thinners again, but we toss out the rags, papers, plastic wrap used to preserve brushes, residue-encrusted jars, disposing of them in a landfill. Will the landfill leak? When will it leak? And when will someone suffer from cancer as a result?

Yes, **GARBAGE** comes none too soon. We need your magazine. We need answers. We need to explore alternatives. Your magazine will help.

William B. Francik Jr.
Lombard, Ill.

Why do so many people use their age as an excuse for not getting involved? We older people have a decided advantage over younger people! We grew up in the pre-plastic, pre-disposable, pre-war years. We lived through the Second World War, and if we were at all aware, we got a good introduction to recycling, way back then. How many of us, I wonder, remember the famous slogan of those lean times: "Use it up, wear it out, make it do – or do without!"

We have more tricks up our sleeves for recycling than a magician does colored scarves! C'mon, senior citizens, we have a lot to share with the younger generations. And it's better to wear out than to rust out, isn't it?

Ann N. Malone
E. Aurora, N.Y.

Ad Policy

You state on page 50 (Sept-Oct) of your new magazine, "I didn't want my business to die from an overdose of higher moral purpose. A dead magazine wasn't going to be much help to anybody."

Well, a dead planet will not be much help either. Imagine my surprise to find full-page ads in your premier issue from General Electric and Coors. That the bulk of your advertising

Donald Betts/Horizon Photographics, Inc.

The remains of a microwavable meal. (Incidentally, the manufacturer's address is on the package.)

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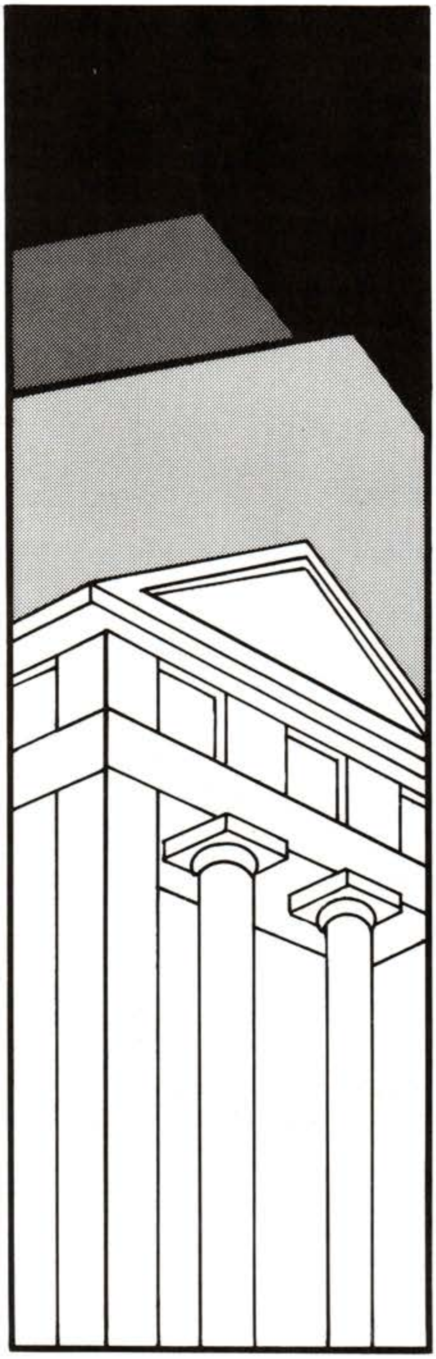

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Harry Williamson
Santa Rosa, Calif.

Thanks for the "From the Editor" message (Nov-Dec). So quickly we get lost in taking sides, being exclusive, etc. It is very encouraging to see an editor address such issues head-on, and with such clarity.

Reading all the ads for the ways "free enterprisers" are devising to address environmental problems is exciting. One forgets that solutions to these seemingly overwhelming problems are limited only by the creativity and drive that we bring to them. Surely this can match the creativity and drive that brought them into being in the first place!

Thanks a million for such a well-done magazine. It can't help but fly!

Holly Cook
Sherborn, Mass.

Comments on Cars

With reference to wood for raised wooden vegetable beds [*Ask Garbage*, Nov-Dec]: Even with rot-resistant types of wood, one should still check that the woods have not been treated with chemicals. I live in the area where redwood products are produced, and I have a hell of a time finding untreated redwood posts, etc. Next, I must take exception to a comment in the car story. Many small businesses use the small pickups for work, not for pleasure. To suggest that small businesses be further penalized with yet another tax is a little much. Let's instead pressure the government to pressure the vehicle makers to produce more efficient trucks, vans, etc. I wish I could find a van that is more efficient.

Finally, a word of praise. Your articles on chemically safe products such as the one on safe paints are extremely valuable for those of us who are chemical-sensitive. Kudos.

J. Cohen
Mendocino, Calif.

I appreciate Janet Marinelli's article on cars and CO_2. It's about time someone put it out there straight.

One point was left out in the discussion of ethanol as an alternative fuel, and that is the cost to the environment of agribusiness farming, which the production of ethanol on any large scale would necessitate. We must consider that unreformed farming practices result in depleted soil, and

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lots of chemical fertilizers seeping into our water supply and waterways. Unless we look at and insist on alternative ways of growing corn – less chemical-dependent ways – ethanol as an alternative would help clean the air at the cost of water and soil. This hardly seems rational.

Margaret Hobart
Pasadena, Calif.

I had mixed feelings about *Global Warming Basics*. Stressing private automobiles as our transportation mainstay for the future is a mistake. Moving people *en masse* will always be more efficient than private cars. Mass transit has, unfairly, a bad reputation for being too expensive, unreliable and impractical. But if gasoline prices were raised to realistic levels and if mass transit received as much subsidization as our highway system does, the cost would be very competitive. I think it's time we Americans stop flaunting our individualism, and plan realistically for our next century's transportation needs.

Hans Rosenburger
Hatfield, Pa.

If the shoe fits...

It amazes me how the word "**GARBAGE**" repels some of our pseudo-fastidious citizens. That may be part of the problem to be overcome if we are to get our hands and our minds into the job of conserving and recycling. We all give off waste.

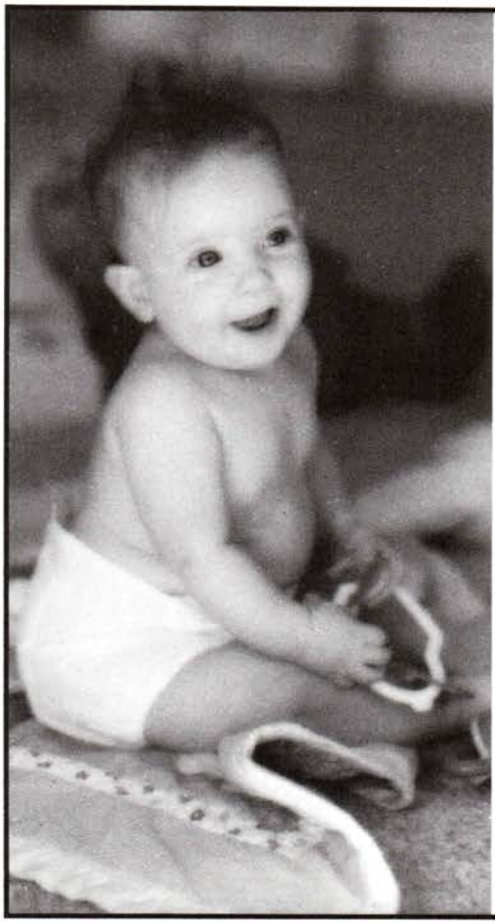
GARBAGE *can* become FRESH AIR. May I suggest to the fastidious who are repelled by the word, that they use the French pronunciation, as in *arbitrage*.

Seymour Tubis
Denver, Colo.

I love the name! To me, it shows a determination to confront the issue directly, without euphemisms. I hate the tearouts! I don't know the official name for them, but you know what I mean: those little perforated cardboard things strewn throughout the magazine that make it impossible to thumb through properly. Please replace them with the kind that can be cut out of a standard page with a scissors.

Paul Bonneau
Gaston, Ore.

I've so far resisted "blow-ins" (those confounded loose cards that fall on the floor), but I'm afraid the bind-ins are there to stay – at least until readers can telepathically communicate their desire to subscribe. They're perforated: Tear 'em out and pin 'em to your office bulletin board! Thanks. – P. Poore



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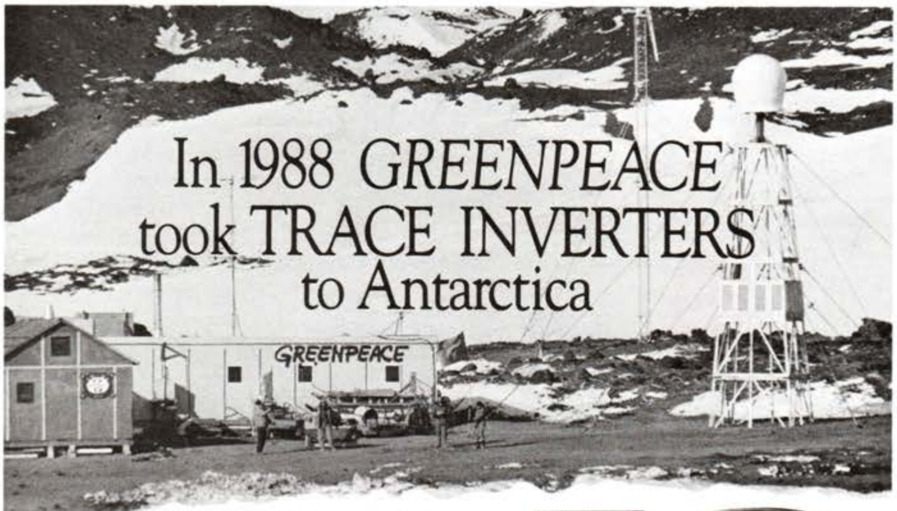

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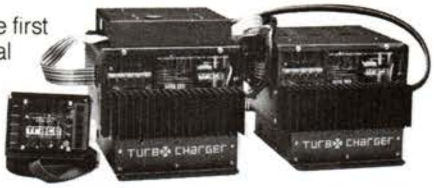

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ASK GARBAGE

Q: *Are the chemicals used in shampoos threatening our waterways? Are those marketed as biodegradable any better?*

Mary Garner
New York, New York

A: People have been using store-bought shampoos for years, apparently without any disastrous effects. Nevertheless, the ingredients in shampoos, which strip away grease (sodium laurel sulfate, diethyl animide, and triethyl animide), are petrochemicals that are unregulated by the Food and Drug Administration for use in shampoos. These substances are generally broken down in a sewage treatment plant. But if they're not, and end up in sludge that gets dumped into the ocean, they will act as pollutants.

Shampoos touted as biodegradable typically found in health-food stores are rarely chemical-free. In fact, many contain methyl- or propyl paraben, petrochemical preservatives used to prolong the shelf life of a shampoo. If you do find a brand that replaces all chemical ingredients with plant extracts and does not list a chemical preservative on the label, buy it in small quantities so it won't spoil.

Shampoo is certainly not as harmful to our waters as household detergents; nevertheless, it should be used sparingly.

Is shampoo bad for the environment?

Are garbage disposals a good idea?

Photos: Index Stock/Black Box

Q: *What's the story on garbage disposals? I'm thinking of installing one in my kitchen sink. Is throwing kitchen waste down a mechanical grinder any better than dumping it in a trash can?*

Lyle Ganske
Cleveland, Ohio

A: Garbage disposals which grind food waste into a pulp that eventually enters a sewage treatment plant or a septic tank (depending on your community) are certainly no replacement for backyard compost heaps. The question gets trickier when composting isn't an option.

There's very little consensus among environmental experts as to whether or not garbage grinders are valuable for city dwellers who don't have access to a backyard. Some contend that organic matter has a much better chance of biodegrading in a sewage treatment plant, where it is attacked by bacteria in aeration ponds, than it ever could in an oxygen-starved urban landfill. For that reason some communities are starting to *require* garbage disposals in new homes. Bob Adler, director of the Clean Water Action Project for the Natural Resources Defense Council, a national environmental group, makes another interesting argument *for* garbage disposals. He claims that because sewage systems are dependent on a certain concentration of bio-waste, the additional trash provided by garbage disposals could actually be beneficial in a dilute waste stream, i.e., one that contained more water than waste.

On the other hand, there are people like Jacqueline Sartoris of the New York City Department of Environmental Protection, Bureau of Waste Water Treatment, who claim that garbage disposals use far too much water to ever be considered worthwhile. In New York, a city that is frequently confronted with diminishing public water supplies, garbage disposals are extremely unwise. According to Ms. Sartoris and others, another argument against disposals is that their waste taxes already overburdened sewage systems.

Different municipalities take different positions on garbage disposals, so your best bet is to consult your city's department of environmental protection for a recommendation. If composting is out of the question for you, and garbage disposals seem to make the best sense in your city, make sure to buy one that will grind waste into a super-fine pulp. When big chunks of food waste end up in a sewage treatment plant, chances are they'll be carted out to a landfill.

GOT A QUESTION?

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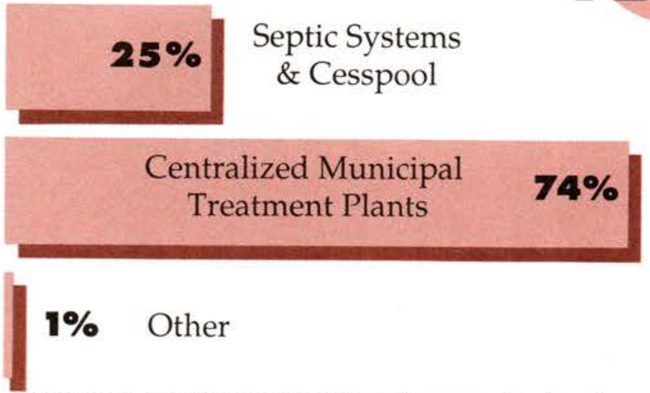
GARBAGE INDEX

AFTER THE FLUSH

How America Treats Its Sewage



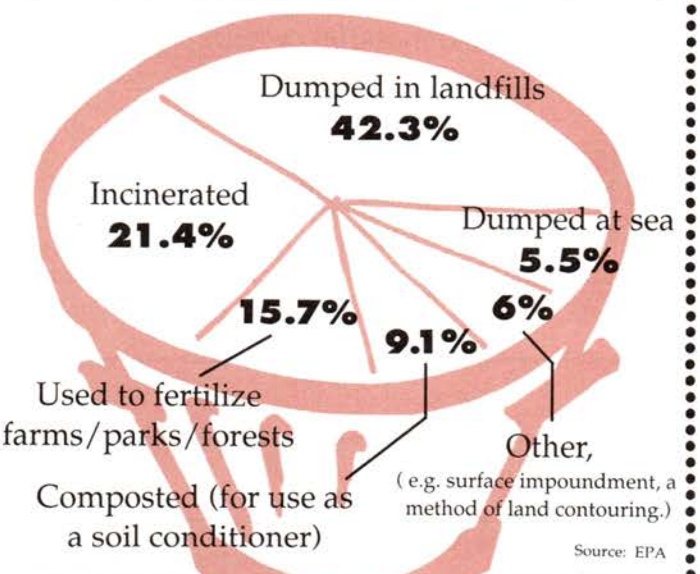
That's now. For the possible future of sewage treatment see the article on page 24.

Source: Detailed Housing Characteristics, U.S. Census 1980

Sludge

Metric tons of sewage sludge generated in the U.S. per year:
7.7 million

How America Disposes Of Sludge



Source: EPA

Although using sludge as fertilizer seems like the obvious choice, sludge is often rife with heavy metals (from industrial wastewater) and with organic chemicals that make it unsuitable for agricultural use..

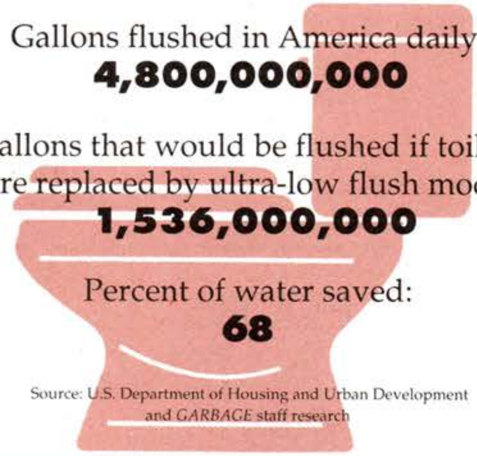
Where Wastewater Originates In The Home

33% Toilet
26% Clothes washing
19.6% Bathing
11.3% Bathroom sink
2.5% Dishwashing (automatic)
5.8% Kitchen sink
1.8% Garbage grinding

Note that the largest single user of household water is the toilet – and that's potable water we're talking about! It would be relatively easy to reduce this waste; see page 16.

Source: *Alternative Sewer Systems*, Water Pollution Control Federation, 1986; and U.S. Dept. of Commerce, National Technical Information Service, 1978.

Toilets



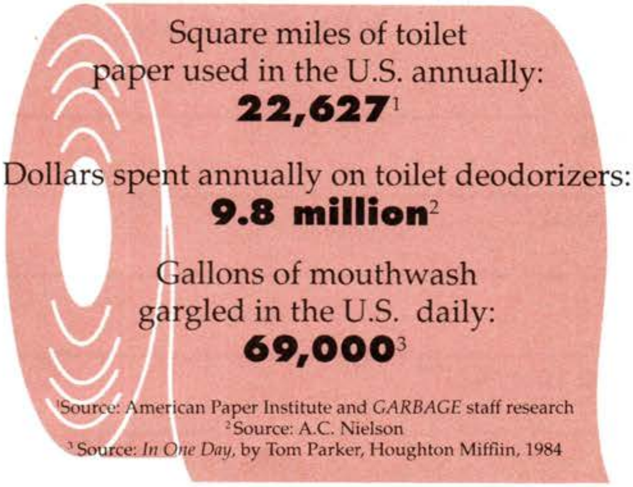
Gallons flushed in America daily:
4,800,000,000

Gallons that would be flushed if toilets were replaced by ultra-low flush models:
1,536,000,000

Percent of water saved:
68

Source: U.S. Department of Housing and Urban Development and *GARBAGE* staff research

Miscellaneous Fun Facts



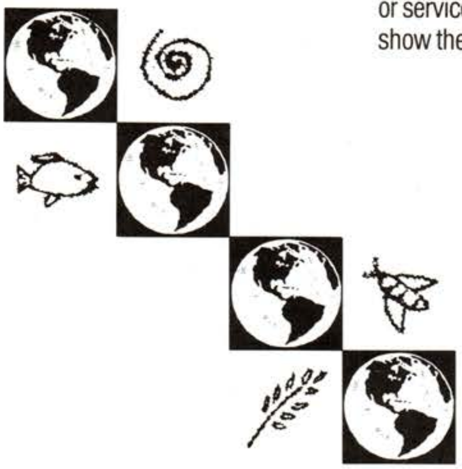
Square miles of toilet paper used in the U.S. annually:
22,627[1]

Dollars spent annually on toilet deodorizers:
9.8 million[2]

Gallons of mouthwash gargled in the U.S. daily:
69,000[3]

[1] Source: American Paper Institute and *GARBAGE* staff research
[2] Source: A.C. Nielson
[3] Source: *In One Day*, by Tom Parker, Houghton Mifflin, 1984

Exhibitors: The Grass is Greener at Earth Options '90!



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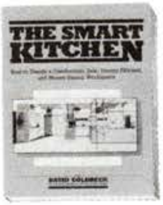

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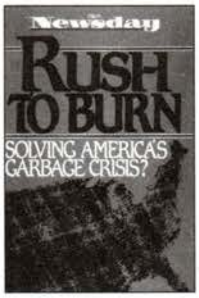

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FOR THE RECORD

"The selling of the environment may make the cholesterol craze look like a Sunday school picnic. So I offer you a warning and a challenge. Let's stay out of this one."

Hubert H. Humphrey III,
Minnesota Attorney General and crusader for honest advertising, admonishing members of the American Advertising Federation against misleading use of terms like "recyclable" and "degradable."

"I don't want to be cold ... but I'm in no position to take the sludge back."

George G. Balog ,
Baltimore public works director, referring to the city's wandering 63-car train of sewage sludge, dubbed the "poo poo choo choo." (*Washington Post*, October 28, 1989)

Cow Gas Is Blamed For Global Warming

From a *Baltimore Sun* headline on a story about methane, a greenhouse gas that destroys atmospheric ozone. Cows, as they digest their food, belch methane.

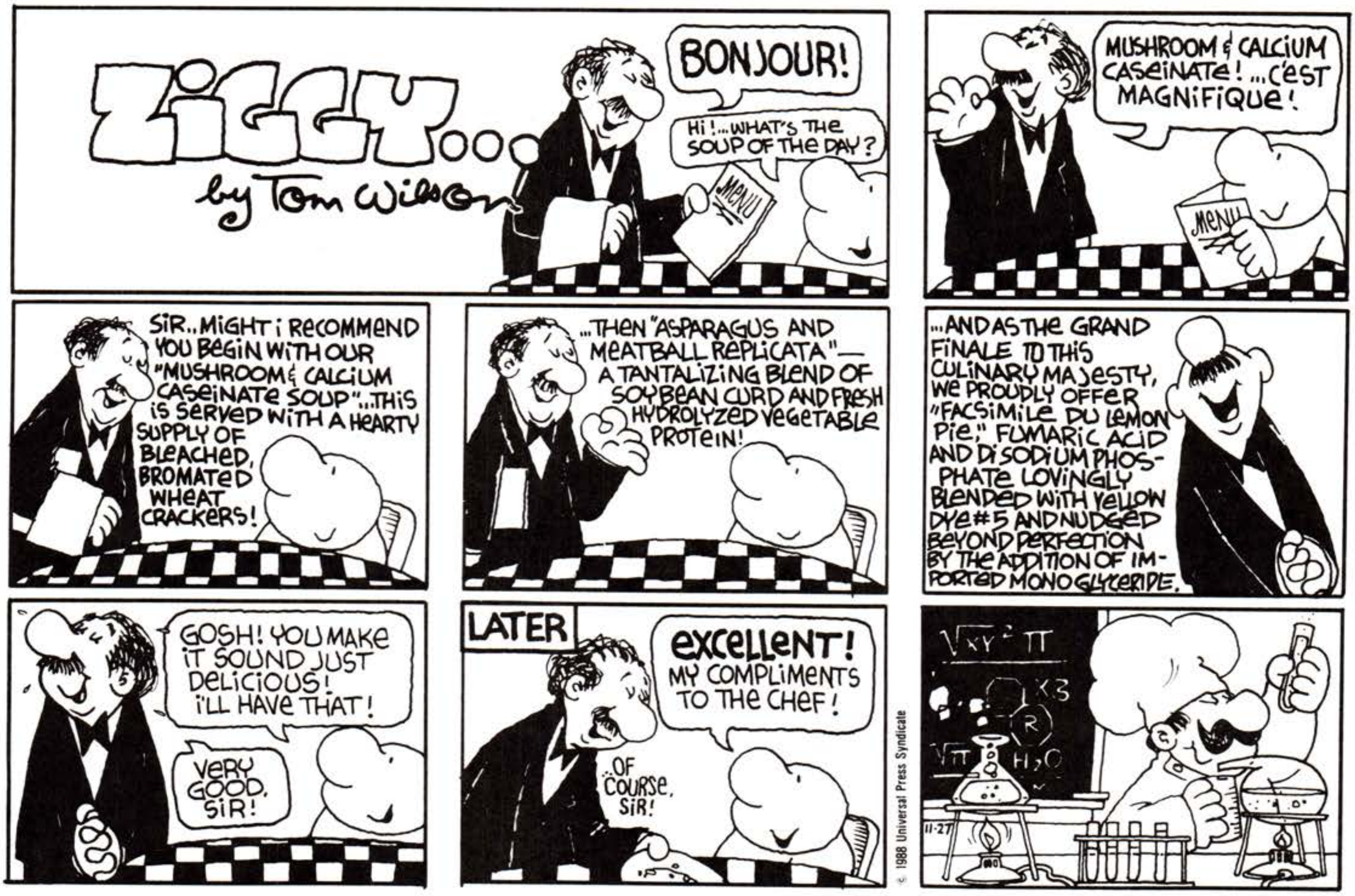
PROFILE

THE GARBAGEGRAM MAN

It used to be that the only time the residents of New Marlborough, Massachusetts, heard from their refuse haulers was when they received a monthly bill, usually tucked under a rock atop a garbage can. Now residents of this sleepy town in the southern Berkshires get a garbagegram.

The garbagegram, a single-page monthly newsletter, comes courtesy of the Berkshires' Master Garbologist, a.k.a Joe Mallory, a private hauler who has been known to wear a tuxedo and top hat while working the back end of a 20-yard truck. First published in June 1985, the garbagegram began as a way for the Master and his wife Robin to communicate with their 2,000 customers and take the sting out of billing. They always close with a "thanks for your time and garbage."

Garbagegrams fill customers in on all local garbage-worthy news. Included in one newsletter is the story of a local litter patrol led by a bird dog that


ZIGGY...
by Tom Wilson
BONJOUR!
HI!...WHAT'S THE SOUP OF THE DAY?
MENU
MUSHROOM & CALCIUM CASEINATE! ...C'EST MAGNIFIQUE!
MENU
SIR.. MIGHT I RECOMMEND YOU BEGIN WITH OUR "MUSHROOM & CALCIUM CASEINATE SOUP"...THIS IS SERVED WITH A HEARTY SUPPLY OF BLEACHED, BROMATED WHEAT CRACKERS!
...THEN "ASPARAGUS AND MEATBALL REPLICATA"— A TANTALIZING BLEND OF SOYBEAN CURD AND FRESH HYDROLYZED VEGETABLE PROTEIN!
...AND AS THE GRAND FINALE TO THIS CULINARY MAJESTY, WE PROUDLY OFFER "FACSIMILE DU LEMON PIE," FUMARIC ACID AND DI SODIUM PHOSPHATE LOVINGLY BLENDED WITH YELLOW DYE #5 AND NUDGED BEYOND PERFECTION BY THE ADDITION OF IMPORTED MONO GLYCERIDE.
GOSH! YOU MAKE IT SOUND JUST DELICIOUS! I'LL HAVE THAT!
VERY GOOD, SIR!
LATER
EXCELLENT! MY COMPLIMENTS TO THE CHEF!
...OF COURSE, SIR!
√XY² π
K3
R
H₂O
11-27
© 1988 Universal Press Syndicate

by Bill Breen

directs workers to cans and bottles. Another trash tidbit: a report on how a New Jersey town stopped construction of a nearby garbage-transfer facility. "Imagine," marvels the Master Garbologist, "being opposed to transferring garbage out of one's own community."

The Master Garbologist initially thought that a chatty newsletter on the less-than-appealing subject of garbage might meet with indifference or, worse, repulsion. But the residents of New Marlborough were surprisingly receptive, and many willingly engaged in a correspondence with the Master. "You have elevated garbage to such a high level that it is getting to the point where I hate to throw it out," replied one customer. "It occurred to me to keep it in the freezer and sell it years from now to the antiques collector."

Belying the garbagegram's tongue-in-cheek tone is a call for local folks to take responsibility for their trash. "We, as a society, do not want to think about our garbage," asserts Joe. "We much prefer someone else to quickly and quietly find a hiding place and dispose of it." Naturally, he tells each of his customers where their solid waste is finally buried.

Other garbagegrams report on how to discard of household hazardous waste, and how composting can reduce organic waste. As local municipalities adopt mandatory recycling laws, bewildered residents look to the garbagegrams for instructions on storing and separating recyclable materials. To spur the recycling movement, the Master Garbologist has collected 183,398 redeemable cans and bottles, and donated the $8,680 in proceeds to seven local charities chosen by his customers. Prodded by the charity recycling program, some households have cut back on waste, making garbage pick-ups necessary only every other week.

While reducing the waste stream certainly benefits the environment, some wonder whether or not it clobbers the private hauler's bottom line. Not so, says the Master Garbologist. "A rubbish hauler is in the business of hauling as much

rubbish as he can, but you can't think that way anymore. We've got to reduce the rubbish rate and increase the recycling rate. We won't lose out; it's just a question of diversifying – even recyclables need to be picked up. Besides, it's the right thing to do."

Bill Breen is a freelance writer from Brooklyn, New York. His environmental and human-interest stories appear regularly in the Christian Science Monitor, Yankee magazine, *and* Newsday.

GARBAGE DICTIONARY

Garbology, noun (singular), from *garbageology*: The study of garbage for an explanation of human attitudes and behavior; or, as Wilson W. Hughes, research anthropologist and co-director of the Garbage Project at the University of Arizona at Tucson says, "interviewing garbage cans instead of people."

The word garbageology turned up in 1975 in a New Behavior magazine article by Arch Napier. Referring to the University's Garbage Project, a trashcan-by-trashcan analysis of Tucson's rubbish, Napier coined the term garbageology and deemed it "America's newest science."

The word has since lost one tongue-twisting syllable, but the science has gained momentum. In 1972, a few Tucson anthropologists began peering into trash cans to compare the diets and habits of people in various neighborhoods. The Garbage Project has since collaborated with the USDA to study nutrition habits, and with the EPA to study recycling trends.

But only in the past four years has the Garbage Project gone for the gusto: the excavation of landfills. Digging into the nation's dumps, garbologists have found that our waste is surprisingly well-preserved. Newspapers as much as 38 years old have been found in perfectly readable condition.

While old newspapers make for easy layer dating, it is alarming to think that in nearly 40 years, the papers have not begun to biodegrade. Landfills are so short on oxygen that little bacterial composting can occur. No wonder some experts are skeptical about cornstarch-baited "biodegradable" plastics.

In a society that throws away as much stuff as we do, garbage digs are bound to unearth some treasures. Found in a Chicago landfill in 1988 were three hot dogs buried in 1972.

— Hannah Holmes

TOILETS

The Low-Flush/No-Flush Story

by Robert Kourik

Are you reading this in America's favorite reading room? If so, before you flush, consider the absurdity of the situation. Water from underground aquifers, costly dam projects, or distant rivers, lakes, and streams is routed through expensive pipes to a complex water-treatment plant where it's purified, then pumped via a costly distribution system to your home — all to whisk away a small "load" (pardon the euphemism). Only the Western industrial mind could conceive of something as complicated as using costly, chemically treated drinking water to wash away human waste. Many of America's commodes use *five to eight gallons* of water to flush from one cup of urine to several cups of feces. It's been estimated that the average American uses 9,000 gallons of drinking water each year to dispose of a mere 130 gallons of excrement and urine. Flushing accounts for over one-third of domestic water consumption.

The author begins research.

The health benefits of a water-borne human waste disposal system cannot be discounted, I'll grant. But in our era of dwindling water supplies, wasting water for flushing — clean drinking water, no less — is a dubious proposition.

Throughout the 1970s and early '80s, environmentalists nagged away about the wanton waste of the five-gallon flush. With lofty visions of a solar-powered, water-conserving society in which all nutrients, even those in human excrement, would be recycled, a small vanguard of zealous environmentalists (including yours truly) championed the waterless or composting toilet. But to be faced — literally — each morning, bleary-eyed, with one's own bodily wastes was aesthetically unacceptable for most of us (see "The Straight Poop on Composting Privies," page 22). Water-conserving, ultra-low-flush toilets are a much less offensive alternative. (See page 18.)

Part of the appeal of composting toilets was the fact that very few low- or ultra-low-flush toilets were available in the '70s and early '80s. The few that were for sale were expensive. Today, over a dozen models are available across the country, from the largest toilet manufacturers as well as small, innovative companies and mail-order suppliers. And some are often available on sale for less than $100. (See page 20.)

• LOW, ULTRA-LOW, OR MICRO

Low-flush toilets are currently divided by popular idiom into three major categories: low-flush or very low-flush toilets using 3.5 gallons per flush (gpf) or less, ultra-low-flush (ULF) toilets using 1.6 gpf or less, and micro-flush toilets using less than one gpf. Proposed American National Standards Institute (ANSI) regulations would mandate the following nomenclature: low consumption for toilets using an average of less than 1.6 gpf, watersaver for those averaging less than 3.5 gpf, and conventional for all the water hogs (not ANSI's phrase).

Ultra-low-flush toilets conserve from 19 to 45 percent (with an average 25 percent) of the water flushed away by conventional toilets. This amounts to a savings of 18,000 to 26,400 gallons per year for an average household.

Low-flush toilets help your wallet as well as the water supply. According to the Rocky Mountain Institute (RMI), an environmental think tank based in Colorado, "it is almost always less expensive to improve the efficiency of water (use) than to search for and develop new sources of water." One RMI study showed that retrofitting Denver with water-conserving faucets, showerheads, and toilets would save as much water as would be provided by the proposed $1 billion Two Forks dam — at 80 percent of the cost.

For homeowners, the benefits can be much more immediate. For instance, a low-flush toilet can minimize the cost of a new septic leach field. The resulting savings on a smaller drain field can, according to RMI, "easily exceed the added cost of efficient fixtures" (including low-flow faucet aerators and showerheads).

How much can you save this month and throughout the year if you don't have a septic system? According to the National Wildlife Federation, savings from more efficient toilets vary with local water and sewer rates, but savings range from $25 to $50 per year. A Stevens Institute of Technology study of eight Columbia, Maryland, households showed that homeowners using one-gallon ULF toilets saved 21 percent more than their neighbors with 3.5 gpf toilets. The Massachusetts Water Resources Authority estimates that installing a 1.6 gpf toilet will save a Boston homeowner $74 per year. This means an average payback of only three years, or a return on investment of 39 percent — making the toilet better than all banks and most stockbrokers!

Whether we want to save water or not, there will probably be a ULF toilet in our future. Currently, 18 communities in six states have mandated ULF toilets in new construction. The proposed National Plumbing Efficiency Act, which has been introduced in both the U.S. Senate and House of Representatives, would mandate a national plumbing standard that restricts *all* new toilet installations to models using 1.6 gpf of water or less. The bill is sponsored by Rep. Chet Atkins of Massachusetts and Sen. Wyche Fowler of Georgia. It also would require that a toilet's water usage and operating costs be listed on product labels.

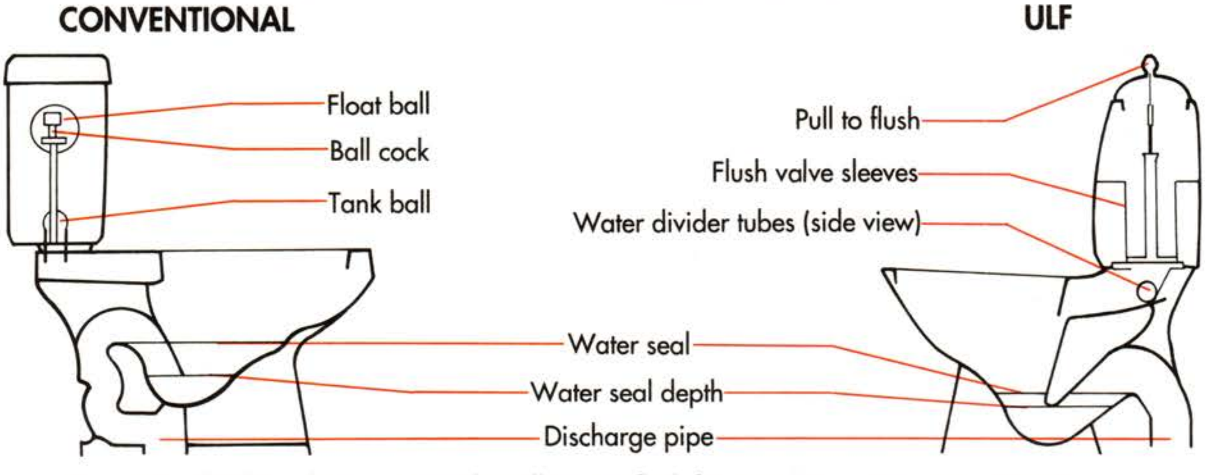
• HISTORY REPEATS ITSELF

Not all old toilets wasted water. High-tank toilets, with the water tanks mounted on the wall close to the ceiling, were among the first low-flush toilets. These old-fashioned commodes, which have been around since the late 1800s, used the velocity of the falling water to help flush the bowl. Depending on the design of the bowl, high-tank toilets used as little as one to 2.5 gpf, and no more than 3.5 gpf. Even some older toilets without the high-mounted tanks conserved water. They had a small surface area of water in the bowl and didn't use a siphon to discharge the waste. So, they used as little as one to 1.5 gallons per flush.

During the early days of the environmental movement, we were admonished to add a brick or two to the toilet tank to save water. While this did save water, the grit sloughing off the bricks also deteriorated the tank's plumbing. So we switched to plastic one-quart bottles or water dams to minimize the volume of water in the tank. In my own toilet, I slightly bent the metal rod that attaches to the float ball to shut the refill off sooner. But there's a limit to the amount of water that can be saved without redesigning the toilet for ULF conditions, and those who were too zealous ended up with "incomplete evacuation of the bowl," or in less delicate terms, some poop left in the toilet after flushing.

During my research for this article, I learned that conventional toilets are even more wasteful than is generally thought. Next time you use a conventional toilet, look into the bowl as the tank is filling. Notice that water is trickling into the bowl the entire time the tank is filling. Many conventional toilets arbitrarily refill the bowl with water at the same time as the tank. But the tank has a much larger volume than the bowl. Consequently, water is running out the trap long before the tank fills, wasting as much as one gallon of water with each refill — on top of the amount of water used to flush! Low-flush toilets solve this problem by either filling the bowl and

CONVENTIONAL VS. ULF



Conventional toilets rely on six to eight gallons per flush for evacuation. Design modifications in ULF toilets make it possible for the commode to work with significantly less water.

HOW TO CHOOSE A ULF TOILET

•Assess your needs and do your homework.
First, call the dealer or manufacturer of your current toilet to find out how many gallons per flush it uses. If it's a water waster (more than 1.6 gpf or at most 3.5 GPF) study the "Buyer's Guide to ULF Toilets" on page 20 for the model that's best for you. Using your water and sewage rates to calculate future savings and length of payback can help you decide. Figure on an average of 3 to 5 flushes per person per day.

•Don't go for the absolute lowest gpf, unless water is very tight.
It's bad enough that most new cars are too complicated for the owners to do their own tune-ups. It could be a costly catastrophe — and most inconvenient — if your mechanical toilet breaks down. For example, the National Park Service installed compressed-air-operated, microflush toilets at Muir Woods National Park in Marin County, California. These were replaced because spare parts for routine maintenance were not available from the manufacturer. If your water supply is extremely tight, a toilet that uses less than one gpf, invariably a mechanized unit, may be your only choice. If so, spend time interrogating folks who've used the model you're considering and test-fire their toilet.

•Pick a toilet with a good-sized water seal.
If skidmarks are going to drive you over the deep end, make sure you pick a toilet with the largest water seal, or total surface area for standing water in the bowl. (See the "Water Seal" column in the chart on page 21.)

•Don't choose the newest model or latest mechanized type.
If you like to be the first on your block to have the latest gizmo, there are plenty of new models to choose from. But be sure to ask your supplier about replacement parts and service.

•Get a listing of installations and visit working models.
Ask your dealer for a listing of local installations.

•Ask friends about their experience with low-flush toilets, and call hotels and public buildings with installations of your preferred models.
Pretend you're from Missouri, the Show-Me State, and visit some working toilets. Although it may raise a few eyebrows at fancy cocktail parties, ask your new acquaintances if they have any experience with ULF toilets and which ones they prefer.

— *Robert Kourik*

its trap first and then shutting off the water to the bowl as the tank continues to fill, or by filling the tank first and then letting a precise amount of water into the bowl to refill the trap.

While toilets look like simple fixtures, they include some ingenious engineering and design. This is especially true of the newer, more innovative toilets. However, as the amount of water required to whisk away daily wastes decreases, the complexity of the flushing mechanism often increases correspondingly, leaving the homeowner vulnerable to Murphy's Law of Plumbing. This time-proven axiom stipulates that plumbing shall break down at the most inauspicious time (such as 4 a.m. on the day of your acceptance of the Pulitzer Prize for Literature when 20 guests are coming over to pat you on the back). The more complicated the toilet, the greater the likelihood that Murphy will invoke his law. All the more reason to know how the various ULF toilets work before you make your choice.

Much modern toilet design has focused on quieting the flush. Sound-reduced toilets are easily recognized: They have a very low, wide tank behind the bowl. Lowering the tank below the rim level reduces the sound of the flush, but also diminishes the drop of the tank's water, so more water must be used to purge the fixture. Consequently, these tanks use no less than 3.5 gpf, often 5 to 7 gpf, and may never reach the proposed 1.5 gpf limit.

• THE ANATOMY OF ULF TOILETS

The illustrations point out the important parts of both a conventional commode and a low-flush toilet. Originally, flush toilets used a siphon action to dump the water from the tank to the bowl. Nowadays, the conventional toilet depends upon the force of gravity to discharge water from the tank. With a conventional tank so close to the bowl, the water usually drops much less than one foot and gravity doesn't have as much influence as it would with a higher tank. To lower the gpf, either the bowl shape, the trap configuration, or the way in which the bowl fills and discharges must be redesigned — or all of the above. (This does not apply to toilets that use electricity, pumps, or compressed air to evacuate the excrement.) Here are some highlights:

"Turbo-charged" Toilets

One ULF mechanism for evacuating the tank is called the flushometer-tank — and it's important to understand how it works because it is currently installed by four different manufacturers representing over a dozen models. Until the pending Congressional legislation forces manufacturers to redesign their lines, it will probably be the most common device for ULF toilets. This design utilizes an ever-present, but until now ignored, source of energy to flush: the pressure within the house's water pipes.

Water entering the flushometer-tank under supply-system pressure compresses entrapped air, "turbo-charging" it. With a flushometer-tank, the water entering the bowl has a force some 500 times greater than a conventional gravity-fed tank with a flapper valve. The force of the turbo-charged water is equivalent to putting a typical gravity-fed tank some 60 feet in the air. This improves the flush in two ways: The toilet's flush cycle is one-fourth the time (less than four seconds) and each flush is 1.5 gpf or less.

What the manufacturer's literature doesn't tell you about is the device's sound. Being a tactile sort of guy, I had to see and hear a flushometer-tank. So, I located one in a Flushmate toilet (the original combination of flushometer-tank and porcelain bowl that's no longer sold by Water Control International (WCI) — the manufacturer) in a nearby feed-granary building. Frequent loading by the employees in this company bathroom truly puts the toilet through its paces. The plant maintenance manager assured me there were no complaints about clogging and no repair problems. He was very satisfied with how the toilet had solved the company's septic and water problems. The surprising part was hearing the thing flush. Now, I knew that most ULF toilets have a noticeable cascade sound. But, with its turbo-charged water, this toilet was *loud*. (My dedication to accurate reporting didn't extend to being able to test-load the thing on demand. Sorry.) The plant's maintenance manager quipped that the toilet's rapid and powerful flush makes the "guys" kid that "you better not be caught sitting on that thing with anything hanging down when you flush!" To be fair, the flushometer-tank was in a typical metal-walled commercial bathroom stall, so the sound might have been exaggerated. Sid Cavanaugh, mananger of technical services at WCI, claims "testing has shown that the sound is not louder. The decibels are the same as a typical toilet." Still, I suggest that you test flush a flushometer-tank, preferably in a home bathroom, before buying one.

I also suggest you make sure the water-line pressure coming into your toilet is 65 pounds per square inch or less. Some homeowners with higher water-line pressure have had to replace damaged units. The manufacturer will replace new flushometer-tanks, but you're on your own once the warranty expires.

Water-Divider Tubes

Ifö's Cascade line of toilets relies upon an innovation called a water-divider tube. It splits the tank discharge into two streams of water, one on each side of the bowl's rim. This produces a jet-stream action that gives the water increased velocity and force, while providing a more direct path to the bowl's rim. The Vénéto ULF toilet has a set of plenums which works much like a water-divider tube, going to each side of the bowl and dumping water through an open, slotted rim. Both designs produce a vortex, sometimes referred to as a "rooster-tail effect," to greatly increase the flush action. A technician at WCI warns that "the rooster-tail effect can cause a splash kick-back that could be a health hazard if the toilet is flushed while sitting."

Water Seal

A critical design consideration in ULF toilets is the water seal surface area, or the total area for standing water in the bowl. Washdown bowls have a much smaller water seal surface area than siphon jet bowls. This is sometimes the cause of what is euphemistically known in the toilet-bowl trade as "skidmarks" — brown streaks left after flushing. If the deposit doesn't land on water first, or all the excrement isn't covered by water, or the water in the bowl or the rim's flush is inadequate, the result is skidmarks. Skidmarks are the nemesis of ULF toilets with an inadequate water seal surface area (and have reportedly resulted in some water-wasting double-flushing). Early imported European toilets were notorious for skidmarks. One such toilet, the Ifö #3180-001, without a siphonic flush, had a water seal surface area of 5"x4", compared to the industry standard 8"x7" water seal surface area or the common siphon-jet water seal surface area of up to 12"x10". Skidmarks are an aesthetic problem, not a health problem, and a peculiarly American one at that. Europeans, less commode-compulsive but nonetheless cleanly, simply reach for a long-handled brush to swish away skidmarks as instinctively as we Americans just wipe and flush.

• HOW WELL DO ULFs FLUSH?

I've used two models of the European-type Ifö one-gallon flush toilet. With both models, I occasionally was able to (putting it ever so delicately) load up the bowl sufficiently to generate skidmarks and require double flushing. At times, the deposit protruded above the water seal, producing a distinctive fragrance (if you know what I mean, and I think you do). Although I have a relatively high tolerance for these things, this is not the kind of toilet I'd give my Mom as a present. It's no longer stocked by the new American manufacturer (Kilgore), but can still be found at some retail outlets and mail-order suppliers. Beware.

Occasional clogging and the need for double-flushing were the legacy of some early low-flush toilets. But recent advances have mitigated these problems. If you tried a low-flush toilet in the 1970s or early '80s and were disappointed, try one of the newer models. They're better.

Nevertheless, some studies of clogging and double-flushing with low-flush toilets have shown mixed results. In one study of low-flush and ULF toilets in a Phoenix, Arizona, subdivision, 28 percent of the users of 3.5 gpf toilets and 45 percent of the users of .8 gpf toilets reported extra cleaning was required to deal with skidmarks. Occasional double-flushing was reported by 67 percent of the 3.5 gpf toilet users and 52 percent of the users of .8 gpf toilets. Surprisingly, 65 percent of those using 3.5 gpf toilets reported clogging, but only 15 percent of the .8 gpf users. This is probably due to the bowl's design or the larger diameter of the trap and discharge tube found in ULF toilets; the larger diameter is required to evacuate waste with so little water. In a Stevens Institute of Technology study, double-flushing was only required 1.6 percent of the time with 3.5 gpf toilets and 2.3 percent of the time with 1.0 gpf models. This averages out to double-flushing once every 10 days per person. (This is the only study I was able to find which didn't rely on the recollection of the user, but rather used a counting device attached to each toilet to get an accurate count.)

I can say from personal experience that the Aqualine 1.5 ULF toilet recently installed in my house performs quite well. There are occasional skidmarks, but most flushes are clean and effective. I particularly like what amounts to a variable flush, depending upon how long I depress the tank's flush lever. The toilet has a well designed, low profile. With no overhang on the tank's lid and the concave curve to the tank, the Aqualine is quite comfortable to lean back against while sitting. On sale for $99 at a local hardware supply house, it was the best deal going.

• TESTING ULF TOILETS

Virtually all the ULF toilets on the market have passed a series of tests called the American National Standards Institute standards. These tests are performed for the manufacturer by

(continued on pg. 22)

A Buyer's Guide to Ultra-Low-Flush Toilets

TOILET	MANUFACTURER	Gallons per flush	ANSI OK*	Flush mechanism	REQUIRES		
					Elec.	Comp. air	Special
Allegro	Mansfield Plumbing Products 150 First St. Perrysville, OH 44864 (419) 938-5211	1.6	yes	gravity-fed	no	no	no
Aqualine	U.S. Brass (division of Eljer) Bobby Rogers 901 10th St., P.O. Box 37 Plano, TX 75074 (800) 872-7277	1.5	yes	flush valve sleeve, open slotted rim	no	no	no
Atlas	Universal-Rundle 303 North Street Newcastle, PA 16103 (800) 245-1753	1.5 (or less)	yes	gravity-fed	no	no	no
CraneMiser	Crane Plumbing 1235 Hartrey St. Evanston, IL 60202 (312) 864-7600	1.6 (or less)	yes	gravity-fed	no	no	no
Economiser	Crane Plumbing 235 Hartrey St. Evanston, IL 60202 (312) 864-7600	1.5	yes	flushometer-tank	no	no	no
Flush-o-matic	Sanitation Equipment 35 Citron Court Concord, Ontario Canada L4K257 (416) 738-0055	0.25	N/A	mechanical trap seal	no	no	no
Hydro Miser	Peerless Pottery P.O. Box 5581 Evansville, IN 47716 (800) 457-5785	1.6	yes	gravity-fed	no	no	no
Cascade	Mansfield Plumbing Products 150 First St. Perrysville, OH 44864 (419) 938-5211	1.6	yes	flush valve sleeve, gravity-fed, water divider tube, open rim slot	no	no	no
Madera Aquameter	American Standard P.O. Box 6820 Piscataway, NJ 08855-6820 (800) 821-7700, ext. 4023	1.6	yes	gravity-fed	no	no	no
Microflush	Microphor, Inc. P.O. Box 1460 Willits, CA 95490 (800) 358-8280 (707) 459-5563 (in Calif.)	0.5	yes	compressed air-and-water sequence valve	yes	yes	no
New Cadet Aquameter	American Standard P.O. Box 6820 Piscataway, NJ 08855-6820 (800) 821-7700, ext. 4023	1.5	yes	flushometer-tank	no	no	no
Pearl	Water Conservation Systems Damonmill Square Concord, MA 01742 (800) 462-3341 (in MA) (508) 369-3951	1 cup	N/A	mechanical chemicals foam flush	yes	no	alcohol-type foam
Plebe Aquameter	American Standard P.O. Box 6820 Piscataway, NJ 08855-6820 (800) 821-7700, ext. 4023 for nearest dealer	1.5	yes	gravity-fed	no	no	no
Quantum	Mansfield Plumbing Products 150 First St. Perrysville, OH 44864 (419) 938-5211	1.5	yes	flushometer-tank	no	no	no
Santa Fe	Artesian Plumbing Products 201 E. 5th St. Mansfield, OH 44901 (419) 522-4211	1.6 adjusts up to 1.9	yes	gravity-fed	no	no	no
Toto	Microphor, Inc. P.O. Box 1460 Willits, CA 95490-1460 (800) 358-8280 (in USA) (800) 541-1505 (in CA)	1.6	yes	gravity-fed	no	no	no
Turboflush model 4700	Briggs 4350 W. Cypress St., Suite 800 Tampa, FL 33607 (813) 878-0178	1.6	yes	flushometer-tank	no	no	no
Ultra Flush	Gerber Plumbing Fixtures Corp. 4656 W. Touhy Ave. Chicago, IL 60646 (312) 675-6570	1.6	yes	flushometer-tank	no	no	no
Ultra-One/G	Eljer Plumbingware 901 10th St., P.O. Box 37 Plano, TX 75074 (214) 881-7177	1.4	yes	siphon jet, gravity-fed	no	no	no
Vénéto (US 9710)	Porcher, Inc. 13-160 Merchandise Mart Chicago, IL 60654 (800) 338-1756 in IL, (312) 923-0995	1.5	yes	gravity-fed	no	no	no
Wellworth Lite	Kohler Company Kohler, WI 53044 (see your local dealer) (800) 456-4537 (for literature)	1.5	yes	gravity-fed	no	no	no

NO. YEARS IN USE	NO. SOLD	SUGGESTED RETAIL PRICE	WATERSEAL		COMMENT
			Size	Depth	
1	10 M	$150	5" X 7"	2" ANSI min or better	Conventional-looking toilet, with lower, narrower tank
since April 1988	10-12 M	reg. $141 elong. $201	4" X 5"	2-1/2"	Low, compact, elegant design; variable flush, depending on how long the handle is held down
1	**	$141	7-1/4" X 4-3/4"	2-5/8"	Conventional-looking toilet
since October 1989	**	reg. $250 elong. $300	reg. 9" X 8 5/8" elong. 11" X 8 5/8"	3"	Series of 6 toilets, reg. & elongated rim for 10", 12", &14" rough-in (distance from wall to center of floor discharge pipe)
3	**	reg. $350 elong. $450	From 9" X 8 5/8" to 12" X 10", depending upon model	2-5/8" to 2-7/8"	Available in a wall outlet model
35	100 M+	215	determined by user	not applicable	Requires discharge pipe-slope of 1/4" per foot; best for rural areas; can add extra water to bowl by partially depressing tank lever
since January 1989	**	$169	reg. 8-1/4" X 8-3/4" elong. 9" X 9"	2-1/8"	Each toilet is tested with a piece of handywipe through the trap before shipping
2	approx. 1-2 M	$200 ($250 after 3/90)	5" X 5-1/2" 9" X 9-1/2"	2" ANSI min. or better	Unconventional, sleek, attractive design
available March 1990	**	$150	12" X 8"	2-1/2"	Commercial product
17	100 M+	$800 $200 for compressor	12-1/4" X 10-1/2"	N/A	Accepted by Uniform Plumbing Code of the International Association of Plumbing & Mechanical Officials; requires only one compressor per household
since March 1989	**	reg. $280 elong. $315	12" X 8"	2-1/2"	Conventional-looking commode, but tank is shorter and closer to bowl
8	**	$795	N/A	N/A	Foam is a biodegradable detergent similar to "natural" shampoo
since October 1989	**	$140	5" X 5-1/8"	2"	Conventional-looking toilet; standard flush handle with typical tall tank
6	30 M+	$325	10" X 12"	2-1/2"	Wholesalers originally received a unit to install at their place of business
since March 1989	7 M+	$100	7" X 8"	2-1/4"	Passed state of Massachusetts & Los Angeles, California, codes
since July 1989	4-6 M	$115	8" X 7-1/2"	2" ANSI min or better	Not a new toilet in Japan; joint venture with Japanese maker with a 71-year history in plumbing products; full rim wash
since April 1989	2 M+	$490	15" X 11-1/2"	2.75"	According to the manufacturer, "the largest water seal surface area in the industry"
1	7 M +	reg. $275.08 elong. $306.18	12" X 10"	2" ANSI min or better	Conventional-looking toilet with low tank
6	**	$150	4-1/2" X 6"	2-1/16"	2-1/8" ball passes through trap
since 1988	**	$595	5" X 5-1/2"8" X 9"	2" ANSI min.or better	Claims to be the only one-piece toilet on the market; French-made; has split plenum to open-slotted rim flush; all plastic flushing mechanism
since February 1989	**	reg. $195 elong. $240	8" x 9"	2-1/2"	Conventional-looking toilet; can be purchased with an Insuliner to prevent tank from sweating

* Approved by the American National Standards Institute

** Considered proprietary information by the manufacturer

*** All prices based on manufacturer's retail price for a plain white model

(continued from pg. 19)

an independent laboratory. Toilets must also be accepted by the International Association of Plumbing and Mechanical Officials, who also review the independent laboratory reports. The city of Los Angeles does its own testing. Likewise, most manufacturers submit test data to Massachusetts officials, as the state has required 1.6 gpf toilets for all new construction since March 1989. Beyond this, little testing has been done.

• CAN YOUR SEWER TAKE IT?

As Massachusetts has led the states in mandating 1.6 gpf toilets, it has the most experience with the so-called transport issue: Is there enough water to carry the stuff from the house to the sewer and all the way to the treatment plant? According to a fact sheet prepared by Amy Vickers of the Massachusetts Water Resources Authority Water Engineering Department: "Low-flush toilets do not cause sewer lines to back up.... Experience and research have proven this concern to be unfounded." Vickers does add a tiny disclaimer: "Only in rare, isolated situations with minimum water uses other than a toilet would such a problem occur." A study of 88 Phoenix homes with ULF toilets similarly concluded that transport is not a problem. I spoke to officials in Santa Barbara, California, and Glendale, Arizona, also in the forefront of using ULFs for water conservation, who concurred.

Note that the proposed ANSI drainline carry test for toilets assumes a 1/4 inch per foot drop in a four-inch sewage discharge pipe from the house to the street. In order to pass the test, 100 3/4-inch balls must pass 40 feet. If you're concerned about retrofitting a ULF toilet, determine the drop per foot of your sewer line (try calling the local department of public works), ask the manufacturer for a technical data sheet on the ANSI #A112.19.6 drainline carry test results, and check with neighbors that already have a ULF toilet. According to studies done by WCI, a conventional gravity-fed, 5.9 gpf toilet transported the balls 57 feet, a 3.8 gpf watersaver gravity-fed toilet carried the balls 50.3 feet, and a 1.6 low-consumption gravity-fed toilet passed the balls only 26.1 feet. WCI says its Flushometer/tank pushed the test balls 59.9 feet.

Some studies suggest that ULF toilets can even *improve* the functioning of septic systems and municipal sewage systems. According to the Massachusetts fact sheet, "Reduction in wastewater volume from low-flow toilets ... will lead to reduced system and sewer maintenance costs...." Research at Pennsylvania State University indicates that reducing the amount of wastewater flowing into a treatment plant can increase detention time (the time the sewage is held in various ponds and tanks for treatment), enhancing the treatment process and extending the life of the plant. Practical, real-world experience with ULFs so far has not created problems with sewer pipes and treatment plants. For example, the Goleta Water District in southern California began requiring low-flush toilets in new construction in 1974 and ultra-low-flush toilets in 1981. In 1986, officials established a rebate program to encourage homeowners to replace existing toilets with ultra-low flush toilets. About 12,500 ultra-low-flush toilets have been installed in the Goleta Water District to date, and there have been no complaints about adverse effects on either sewer lines or treatment plants. A number of other cities and water districts have also installed thousands of ULF toilets, and I haven't heard any major complaints.

THE STRAIGHT POOP ON COMPOSTING PRIVIES

A compost privy is a dry toilet that doesn't need water for flushing and (theoretically) turns human excrement into compost that can be used in the landscape. Compost privies were of particular fascination to environmentalists who promoted renewable energy and environmentally sound technologies (then known as appropriate technologies) during the early and mid 1970s. Environmentalists, galvanized by the gas shortages of the '70s, loved composting privies not only because they could eliminate the water used to flush, but also because they could recycle plant nutrients back to the soil and therefore avoid the use of petroleum-based fertilizers. But the practical, or more accurately, the impractical, realities of composting privies were a far cry from the original vision.

I vividly recall my first sojourn to the Farallones Institute Rural Center, one of the most vociferous champions of composting toilets, in 1978. A budding landscape designer, I viewed with the misty eyes of a true believer the Institute's bio-intensive gardens, greywater systems, solar buildings, and compost privies. Little did I know that I would become a staff member by the end of the following year ... or that I would come to have some "close encounters of a turd kind" (sorry) that would cause me to have grave doubts about compost toilets.

Some of the first compost privies designed by Sim Van der Ryn, one of the founders of the Farallones Institute, were built at the Green Gulch Center in Marin County. Ben (not his real name) recalls his hair-raising experience with one of these toilets: "My son was two years old at the time and was afraid to go to the bathroom alone. I held his hand each time so that he wouldn't be afraid of falling into the privy. One day, I had the flu so bad I didn't want to take him to the bathroom. Moments later, I heard this frantic cry — 'DAD!!' Sure enough, his greatest fear had been realized — he'd fallen through the hole." Luckily, Ben's family applied plenty of sawdust after each use, so his son wasn't ankle-deep in excrement. Father and son survived, but you won't find a compost privy in their current house!

The first privies built at the Rural Center were similar to the one at the Green Gulch Center. A two-chambered privy, called a vault privy, was built near the communal kitchen. An enthusiastic staff member and interns performed the requisite maintenance, including turning the piles, monitoring bugs, odors, and decomposition, and eventually distributing the compost beneath ornamental plantings by burying it in deep trenches.

Since the pile in the privy's vault was built slowly, one load at a time, and plenty of chopped straw had to be added to keep it aerated and absorb urine, the "compost" never approached the hot temperatures required to quickly decompose organic matter or kill pathogens and parasites. And a report dated February 1981 to the California Small-Scale Appropriate Energy Technology Grants Program (an Institute funder) noted in so many words that the staff was no longer enthusiastic about turning this "compost," shoveling it out of the vault, and burying it in the garden. Surprise!

A"new, improved" compost toilet was designed and constructed to rectify some of these problems. Dubbed the Solar Maximus, it featured a larger chamber, baffles within the chamber to help aerate the composting pile, a solar-charged chimney to help exhaust fumes, and a solar hot-air panel to add additional heat to the composting pile. In the Institute's 1979 annual report, the Solar Maximus was trumpeted as "probably the most technologically sophisticated outhouse the world has ever seen."

As fate would have it, my house happened to be one of four (sheltering seven people) which shared the privy. The Maximus's solar-charged hot-air panel was supposed to assist the composting process by providing hot air to the composting chamber below the toilet seat. Now, some people don't know poop from compost. But as a self-appointed "captain of compost" (see the November/December issue), I knew that adding extra heat around the pile doesn't stimulate the aerobic bacteria that decompose the waste; it just increases the oxidation of the organic matter. Oxidation is a non-flammable form of slow combustion, but not at all related to biologically active composting. At best, oxidation generates nutritionally depleted fiber and at worst, fiber that more closely resembles ash. In both cases, the finished material is low in valuable nitrogen because it has been volatilized as a gas. While fiber and ash are important soil improvers, by no stretch of the imagination are they compost, which has organic matter, humus, and higher quantities of the important nutrient nitrogen.

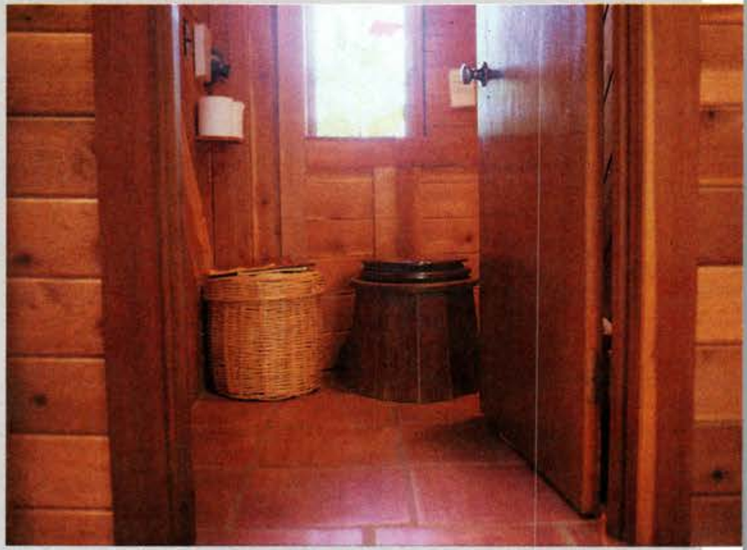
Even worse, the massive amount of heat generated by the hot-air collector in the summer caused a blast of hot air that blew a good portion of each handful of shredded straw thrown down the hole back into one's face. This blast of hot air smelled a lot like a horse's stall on a sultry August afternoon.

While I lived near the Maximus, I participated in an unofficial contest which I called "see how they run." The object was to see who could count the most mice between the time one had left a deposit and the time one shut the lid of the privy. As I recall, the record was more than a dozen.

Perhaps the most troubling aspect of the Farallones's privies was the persistence of parasites, a problem that never was solved. With all the visitors and the numerous consultants and staff that traveled to underdeveloped countries, there was no control over the types of disease and parasites introduced to the toilets. It was the explicit aim of the Institute's dry-toilet research to develop a composting process hot enough to kill all diseases and parasites. However, a number of tests revealed viable hookworm, whip worm, and round worm in the "composted" feces. (In fairness to the Institute, pathogens and disease aren't such a problem in a typical nuclear family.)

Photos by George Ballis

What comes out of the Sun Mountain compost privy.



The only compost privy the author has ever loved, at Sun Mountain Medicine Ways outside of Fresno, California.

In my experience, the biggest casuality of the appropriate technology movement of the 1970s was the composting toilet. Take it from me: Stumbling into the privy very early on a cold winter's day and coming face to face with your (or someone else's) bowel movement is a rude awakening at best. A footnote: My quest for a truly workable composting toilet recently ended with George and Maia Ballis at Sun Mountain Medicine Ways, an educational facility and model of renewable energy in the dry foothills northeast of Fresno, California. The 5,000-square-foot passive-solar main building incorporates a greywater system, solar hot water, an array of photovoltaic 12VDC panels, and a pleasant compost privy (see the photo). The privy was installed in June 1984, and no material was removed until May 1988. George must draw off the urine that filters through the excreta and sawdust to the bottom of the chamber every four to six months and expects to remove finished compost every 12 months. George's recipe for maintenance calls for "adding three cups of sawdust per day, unless we're having a workshop. Then I add three cups per person per day." A fan is built into a vent stack so that any odors are whisked away while the toilet is in use. George buries the finished material beneath various fruit trees in the three-acre garden.

— Robert Kourik

George and Maia Ballis' compost privy is available from Composting Toilet Systems, 1211 Bergen Rd., Newport, Washington 99156-9608; (509) 447-3708. If you're interested, we can send you more information on composting toilets. Use the coupon on page 62 and circle number 33. — the editors

AFTER THE FLUSH

THE NEXT GENERATION

There is an alternative to expensive, cranky, energy- and often chemical-intensive conventional sewage treatment. It's called Nature.

by Janet Marinelli

My husband Don, an environmental planner, is a tolerant guy. But like many of his colleagues in water-pollution control, he likes to tease Perrier-sippers like me who spend a lot of time worrying about water. As I researched this article, I made noises about The Sad State of America's Waterways and wondered what "they" (read Don) are gonna do about it. "We already know what to do about it," he said. "The solution to pollution is dilution." That joke is as old as the profession of sanitary engineering.

As soon as the water closet was invented and the first sewer was built to whisk away our wastes, "dilution" became the solution. It still is. Eighteen years after the passage of the federal Clean Water Act and its "zero discharge" mandate (translation: Congress wanted *all* pollutants removed from wastewater before it was discharged into waterways), municipal officials are still struggling to remove only some of the contaminants put into the water by families, factories, and businesses. Modern sewage treatment plants release effluent (the fancy word for the liquid that leaves a treatment facility) that's full of nitrogen and phosphorus and toxic metals and chemicals into receiving waterways. They also generate an estimated 8.5 million tons of sludge every year.

Conventional sewage treatment has reached a dead end. Making further improvements in water quality with the mechanical and chemical technologies used in advanced wastewater treatment today would cost a fortune, create even more sludge, and in many cases require the use of substances that are far more dangerous than the pollutants they're supposed to remove.

There is an alternative. "Natural" sewage systems modeled after nature's own purifying powers are already treating the sewage of some forward-thinking communities. Cattails, reeds, and rushes in man-made marshes are extracting toxic chemicals and metals from highly polluted wastewater. Canna lilies are cleaning up the discharge from backyard septic tanks. In a New England greenhouse, microorganisms, marsh plants, snails, and fish are transforming raw sewage into purified water. These bioengineered systems can *restore* water, not just treat it. They can do it relatively cheaply, and without generating humongous quantities of sludge.

Sound like the *Whole Earth Catalog* gone bonkers? Maybe. Nonetheless, these "marsh-ecology" systems are turning our notion of sewage treatment on its head.

Above: sewage treatment for the 21st century (Arcata Marsh, Arcata, California).

• CLOACA MAXIMA

For most of history, humans didn't flush their feces and urine into the nearest river. They returned it to earth. The many microorganisms that live in soil digested the excreta and turned it into food for plants. It was when people started settling in cities that sewage became an engineering nightmare. We all learned about the magnificent aqueducts of ancient Rome. But what history teachers don't tell us is that the first major monument to Roman engineering genius was, as Lewis Mumford put it in *The City in History*, "the Cloaca Maxima, the great sewer, constructed on a scale so gigantic that either its builders must have clairvoyantly seen...that this heap of villages would become a metropolis of a million inhabitants, or else they must have taken for granted that the chief business and ultimate end of life is the physiological process of evacuation." In any event, neither Rome nor any other ancient city had much effect on the total environment. There was plenty of water to dilute howevermuch they could pollute.

Robert Gearheart

In the 19th century, cities boomed, overwhelming sewage disposal systems. New York, Chicago, and San Francisco reeled from typhoid, cholera, and other sewage-related epidemics. The first comprehensive sanitary sewer system was constructed in Chicago in 1855. The first sewage treatment facility in New York City was opened in 1886 to protect Coney Island's world-famous beaches. Water disposal of wastes went a long way toward eradicating typhoid and cholera in the U.S. and other industrialized countries.

But by the 1960s, waterborne sewage disposal was getting out of hand — again. The sheer volume of waste from toilets and factories, and from polluted runoff from city streets, garbage dumps, and farmlands was far exceeding the diluting and natural cleansing abilities of our waterways. In 1969, the oily, chocolate-brown Cuyahoga River in Cleveland burst into flames. Lake Erie was pronounced dead.

Suddenly, there was immense public pressure to do something about the disgraceful state of America's waterways, and do it fast. In 1972, Congress passed the Clean Water Act and empowered the new Environmental Protection Agency (EPA) to enforce discharge standards and dispense federal funds for sewage treatment. As *Waste to Resources*, a U.S. Department of Energy publication extolling the virtues of alternative technologies for sewage treatment, put it more than 10 years later, the emphasis on quick cleanup "tended to discourage innovation and favor construction of systems based on standard designs." Concrete-and-steel megasystems became the order of the day (see page 30).

• DILUTION IS NO LONGER THE SOLUTION TO POLLUTION

Since 1972, federal, state, and local agencies have spent more than $72 billion to improve our sewage systems. It can be argued that the money was well spent. The quality of many waterways has improved, in some cases dramatically.

However, most municipal treatment plants are required to treat wastewater only to the "secondary" level. (Among other things, that means roughly 90 percent of the solids are removed). Only about 40 percent receives "tertiary" treatment, meaning nitrogen and phosphorus and most suspended solids (tiny pieces of pollutants floating in sewage) are removed. Yet there's a growing consensus among environmental scientists that secondary treatment is simply not good enough.

Among the substances that pass largely unaffected through the typical treatment plant are herbicides and insecticides and toxic industrial chemicals. Some "trace organics," as these are known in the water-pollution-control trade, can persist in the environment and accumulate in fish tissues, and eventually in us.

Toxic metals, including mercury, cadmium, and copper, also bioaccumulate in fish and pose a threat to human health. These metals become especially concentrated in the sludge produced by conventional treatment plants. "Pretreatment" standards are supposed to limit the levels of metals and other pollutants that some industries are allowed to discharge into municipal sewage-treatment systems. But studies in New York City suggest that even if industrial wastes were effectively pretreated, metals in municipal wastewater could still be a problem.

Aquatic biologists are also increasingly concerned about the huge quantity of nitrogen and phosphorus discharged into the nation's waterways. Secondary treatment not only does not remove nitrogen and phosphorus, but it also turns the organic forms of these nutrients into mineral forms that are *more* likely to feed algae blooms which can suck the dissolved oxygen out of waterbodies, choking off both plant and animal life. Many scientists believe that the nitrogen and phosphorus leaving treatment plants, combined with the fertilizer running off of farms and lawns, is contributing to the decline of many of our most productive fishing areas. Curbing nutrient pollution is, for example, a primary focus of efforts to save the Chesapeake Bay. In highly populated areas such as the Chesapeake, the Hudson River estuary, and Narragansett Bay, sewage-treatment plants are big contributors to the nutrient problem.

Conventional advanced wastewater treatment can remove all, or almost all, of these contaminants. For instance, breakpoint chlorination and chemical precipitation using aluminum are techniques used to remove nitrogen and phosphorus, respectively, from effluent. They're dramatic examples of what's wrong with conventional treatment.

In the breakpoint process, sewage is socked with high concentrations of chlorine. The result is innocuous nitrogen gas — *and* potentially deadly chloroform and chloramine which, along with any remaining chlorine, must be removed with activated carbon filters before the effluent can be safely discharged into a waterway. Chlorine, even in low concentrations, can kill aquatic life. Chloramine is a carcinogen. Many chlorine compounds cannot be broken down biologically into more benign substances. By the same token aluminum, a toxic metal used to get rid of phosphate (a form of phosphorus) in wastewater, produces a toxic sludge which must then be disposed of on land.

Non-toxic alternatives like reverse osmosis, in which semipermeable membranes are used to trap phosphorus and other pollutants, are extremely expensive. But the ultimate irony of conventional tertiary treatment is that the better the water gets, the worse the sludge problem becomes.

• WHAT YOUR BIOLOGY TEACHER DIDN'T TELL YOU

In 1986, 27,692 million gallons of raw sewage were treated by 15,438 municipal treatment plants in the U.S. every day. According to the EPA, we can thank 160,000 industrial and commercial facilities for some 12 percent of this slop, including an estimated 92,000 metric tons of hazardous pollutants annually. For the other 88 percent, we can thank ourselves.

What's in household wastewater? Even sanitary engineers have only the vaguest idea. The subject of bodily elimination is so taboo that generations of engineers have been designing systems to treat they-barely-know-what.

According to the EPA, we throw thousands of tons of toxics, from decloggers to cleaners, down the drain each year. Tons of phosphates originate in our washing machines and increasingly in our dishwashers.

But by far the largest percentage of household wastewater, about 35 percent, originates in our toilets. Aside from water, this stuff consists of feces — itself largely water, carboniferous vegetable fiber, and bacteria from the colon. And urine, which contains most of the nitrogen (in the form of ammonia, which is toxic to fish) and half of the phosphorus excreted by the human body. An average adult produces about 1 to 1-1/2 cups of feces and about four cups of urine a day. Multiply these figures by the 172 or so million Americans hooked up to municipal treatment plants and you begin to understand the organic and nutrient "loading" problem.

Lake Erie is the classic example. By the late 1960s, nitrogen fertilizers from farmlands and phosphates from household detergents were causing huge algae blooms. When algae die, they sink to the bottom. The bacteria feeding on them multiply and consume large amounts of oxygen, robbing it from fish and other aquatic life. Bacteria also decompose the organic matter in human excreta, not to mention the organic compounds in industrial waste, sucking even more oxygen out of the water. Things got so bad that in late summers, a 2,600-square-mile area of Lake Erie was a "dead zone" — no oxygen was available within ten feet of the bottom. This brought about wholesale changes in lake life, driving away important commercial and sports fish. Ancient history, you say? Well, today there is a 2,000-square-mile dead zone near the mouth of the Mississippi River in the Gulf of Mexico, thanks largely to nutrient pollution.

• EVOLUTION OF A REVOLUTION

Rivers, lakes, and streams have an uncanny ability to cleanse themselves. Sunlight bleaches out some pollutants. Others settle to the bottom, and stay there. Many are broken down by bacteria. In a healthy body of water, the oxygen that sustains these bacteria, as well as fish and other organisms, is replenished by natural aeration from wind and wave action, and by aquatic plants, which create oxygen during photosynthesis. Wetlands (the fashionable word for what used to be known as marshes, swamps, and bogs), among the Earth's most biologically active environments, are exceptional natural filters for removing water pollutants.

Dr. Bill Wolverton designed the first working aquatic-plant sewage-treatment system for NASA in the mid-1970s.

Dr. Bill Wolverton discovered the cleansing ability of wetlands in the late 1960s, while mucking around in a Florida marsh. He was developing defenses against biological warfare for the military. "Where there were a lot of marsh plants," he remembers, "the water was a lot cleaner."

Several years later, Dr. Wolverton, who'd added a Ph.D. in environmental engineering to his previous training in chemistry and microbiology, joined NASA's National Space Technology Laboratories in Bay St. Louis, Mississippi, where he hoped to develop what are known in NASA technobabble as "Closed Ecological Life Support Systems" for space

SEWAGE DICTIONARY

Activated sludge — Sludge that has been aerated to provide oxygen for the aerobic bacteria that break down the organic matter in sewage. The activated sludge process is used for secondary treatment at most conventional treatment plants.

Advanced wastewater treatment — See *tertiary treatment.*

Aerobic bacteria — Bacteria that can live only in the presence of oxygen.

Anaerobic bacteria — Bacteria that can live without oxygen.

Bioaccumulation — The accumulation of environmental pollutants in the tissues of living organisms, from plants to people.

Biological oxygen demand (BOD) — The dissolved oxygen needed to decompose organic matter in water. BOD is used as a measure of pollution, since heavy waste loads need lots of oxygen to be broken down.

Breakpoint chlorination — A tertiary sewage treatment technique in which partially treated wastewater is socked with high levels of chlorine to remove nitrogen.

Combined sewer system — A sewer system that carries both sewage and stormwater runoff. During dry weather, both wastewater and runoff goes to the sewage treatment plant for treatment. During rainstorms, the system often gets overloaded, sending raw sewage into the nearest waterway, a big problem in many older cities.

Conventional sewage treatment — Wastewater treatment that relies on an array of expensive and energy-intensive mechanical equipment and sometimes toxic chemicals.

Detention time — The amount of time that sewage is held in a tank or pond so that the intended treatment can take place.

Digester — A closed tank in which sewage sludge is heated and broken down by bacteria.

Dissolved oxygen — A measure of the amount of oxygen available for aquatic life. Inadequately treated sewage can lead to low dissolved oxygen levels and therefore harm fish and other aquatic creatures.

Effluent — The treated wastewater that comes out of a treatment plant.

Eutrophication — The presence of lots of algae and not enough oxygen in a waterbody, due to nutrients, especially nitrogen and phosphorus from wastewater and runoff. In extreme cases, the waterbody turns slimy green and smells.

Gravity thickeners — Large tanks used to remove some of the liquid in sludge.

Heavy metals — Metals with high molecular weights, including mercury, lead, cadmium, and copper, which are toxic to plants and animals even in low concentrations.

Influent — Bureaucratese for the wastewater flowing into a sewage treatment plant. (Compare *effluent.*)

Mechanical sewage treatment — See *conventional sewage treatment.*

John C. Stennis Space Center

This "rock marsh," designed by Dr. Wolverton for a mobile-home park in Pearlington, Mississippi, can treat 10,000 gallons of wastewater a day.

travel (in plain English, ways to grow food and recycle wastes). It was here that he put his discovery to the test. In the mid '70s, the Space Lab's sewage treatment system, a series of settling ponds and a small but cranky conventional "package" treatment plant, was violating water-quality standards. Dr. Wolverton marched into the lab director's office and announced, "Instead of spending millions on a conventional facility, why don't we just grow some wetland plants?" The reaction: "Well, they all thought I was crazy." But the NASA lab had already spent $50,000 just to study which type of conventional treatment would work best, and finally the lab director came around.

Dr. Wolverton proceeded to design a simple system using water hyacinths, an aquatic nuisance species down South, to clean up NASA's sewage. In the past ten or so years, he gleefully points out, the Space Lab has saved millions of dollars by cleaning up the waste of more than 4,000 people on its 150,000-acre site with *weeds*. The facility is generally acknowledged to be the first working aquatic-plant treatment system in the U.S.

Bill Wolverton wasn't the only one interested in alternative treatment systems. The initial response to the Clean Water Act, to quote from *Natural Systems for Waste Management & Treatment*, a bible for engineers interested in the natural approach, may have been "to assume that the 'zero discharge' mandate of the [1972 Clean Water] law could be obtained via a combination of mechanical treatment units capable of advanced wastewater treatment..." (Engineers like to distinguish between "mechanical" systems, which treat sewage with a procession of energy-intensive mechanical equipment, and "natural" systems, which typically include pumps and pipes to move around the waste but don't depend on external energy sources exclusively to maintain the treatment process.) "However," the manual continues, "the energy requirements and high costs of this approach soon became apparent, and a search for alternatives commenced."

The first natural technology to be discovered — or rather *re*discovered, since this used to be the only way to treat wastes — was so-called land application. In land application systems, wastewater is allowed to flow over land at varying rates. Various physical, chemical, and biological reactions in the soil "treat" the sewage while reusing the nutrients, minerals, and organic matter in the waste. During the 1970s, there was considerable interest in land application, but nothing like the current excitement over the newer marsh-plant systems. Land application is used in a few communities today.

It's been only about 20 years since scientists, no less engineers, have been intrigued by the ability of *plants* to purify water. In 1976, the first international scientific conference on biological control of water pollution was held at the University of Pennsylvania. Wastewater engineers were introduced to the concept at a conference at the University of California at Davis three years later. In the ten or so years since, the concept has progressed from lab experiments to pilot-scale facilities to full-blown, real-world systems.

At first, attention focused on simple water-hyacinth systems. When it became obvious that these plants would work year-round only in the South, engineers turned their attention to systems using marsh plants — cattails, reeds, bulrushes, and the like — which can survive in wintry northern climates. Today, there are about 70 man-made marsh and aquatic systems treating municipal sewage in this country,

Natural sewage treatment — Treatment that relies as much as possible on natural processes at work in wastewater.

Nitrogen — A nutrient most commonly found in sewage in the form of ammonia and nitrates. Too much nitrogen in waterways causes algae blooms, and ammonia is toxic to fish.

Nutrients — Inorganic compounds (in sewage effluent, usually nitrates and phosphates) essential for plant growth. Waterbodies with high levels of nutrients contain lots of algae and aquatic weeds.

Organic matter — Matter that came from a living organism. In sewage, this includes poop and pee and the ground-up food matter from garbage disposals.

Phosphates — Inorganic compounds essential to the growth of algae. In wastewater, mostly from laundry and dishwasher detergents.

Phosphorus — A nutrient most commonly found in sewage in the form of phosphates from detergents. A primary cause of algae blooms in waterways.

Polishing — The final treatment process, used to squeeze out even more pollutants.

Preliminary treatment — The first thing that happens at any treatment plant: Large objects (tampons and condoms) and "floatables" (plastic tampon applicators) are screened out and grit is removed.

Pretreatment — Removal of some pollutants from wastewater, usually industrial wastewater, before it gets to the municipal treatment plant.

Primary treatment — The first stage of sewage treatment: The wastewater is held in settling tanks or basins so that roughly one-third of the biological oxygen demand and two-thirds of the suspended solids are removed.

Runoff — Water from rain, snow melt, or irrigation, which flows over the ground and collects pollutants before it reaches a waterbody.

Secondary treatment — The second stage of sewage treatment, in which bacteria are used to treat the wastes. Removes about 90 percent of the biological oxygen demand and the suspended solids.

Septage — The truly disgusting stuff pumped out of septic tanks by honey wagons. Often includes restaurant greases, toxic industrial byproducts, and hospital wastes.

Sewage — The slurry that travels through municipal sewer pipes and includes mostly water from toilets, sinks, washing machines and dishwashers, but also human excreta, detergents, cleaners, decloggers, tampons, condoms, and other miscellaneous items, and industrial wastes.

Sludge — The thick slurry of "solids" removed from sewage at treatment plants.

Suspended solids — Tiny pieces of pollutants floating on or suspended in sewage.

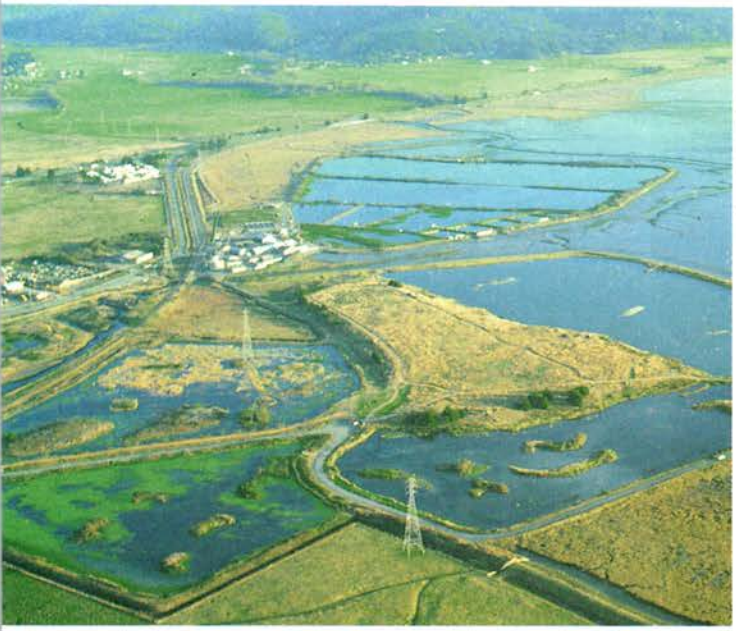
Tertiary treatment — Advanced cleaning of wastewater that goes beyond the secondary stage and removes nutrients such as nitrogen and phosphorous and most suspended solids.

Trace organics — Carbon-based industrial compounds which can be toxic and resistant to biological decomposition and persist in the environment. EPA calls the most worrisome of these "priority pollutants."

Wastewater — See *sewage*.

Wetlands — The trendy term for what used to be known as marshes, swamps, and bogs.

Arcata, California's sewage-treatment marshes, top, saved millions of dollars and created sorely needed wetlands for fish and waterfowl.



Photos: Robert Gearheart

Above, an aerial view of the Arcata marshes.

according to the best estimate of Bob Bastian of the EPA. Hundreds more man-made marshes are treating the highly acidic water that flows from coal-mine sites. And in a handful of experiments, constructed wetlands are also being used to treat industrial wastes and agricultural and stormwater runoff.

The biology involved is simple. In water-hyacinth systems, for example, the plants are grown hydroponically (without soil) in man-made ponds. The plant roots are home to large numbers of bacteria and other microorganisms, which feed on the minerals and organic matter in wastewater. While digesting the pollutants, the bacteria and protozoa produce sugars and amino acids, providing the plants with food. The plants, in turn, supply oxygen and low levels of nutrients to the microorganisms. Leaves above the water surface provide a shady canopy that limits penetration of sunlight and controls algae growth. The same process is at work in man-made marsh systems, except the plant roots penetrate the soil, gravel, rock, or other support medium. What's more, the roots of most marsh and aquatic plants are not only good at removing human excreta from wastewater; some species also remove toxic metals, trace organics, and even radioactive elements.

So what do these sewage systems look like?

• ARCATA MARSH — AND SANCTUARY

About 15 years ago, a handful of folks in Arcata, California, knew their town was in trouble. California was bulging with federal sewage-treatment dollars and state bureaucrats knew just how they wanted to spend it: on a regional sewage plant for Arcata, a timber and fishing town with a population under 15,000, and two neighboring towns discharging inadequately treated wastewater into Humboldt Bay.

Those who balked at the plan feared that miles of sewer pipes running through the area's sleepy farms and forests would be followed by a flood of developers. When the pricetag of the megasystem ballooned to $56 million and Frank Klopp, Arcata's public-works director, concluded that maintenance costs could double the city's sewage rates, he made a beeline for the mayor's office and declared that they really ought to get out of the arrangement. Gradually, others agreed. The result: One of the nation's first marsh-ecology sewage treatment systems was completed in 1987.

In a Humboldt State University (HSU) film about Arcata's man-made marshes, bird cries rise with the dawn over thickets of cattails and bulrushes, a cloud of ducks lifts skyward, and a sandpiper scoots across mudflats. No great surprise. The big surprise of the Arcata experiment was how quickly the marshes were adopted by *humans*. In an area where you can choose a redwood forest or a secluded Pacific beach, many Arcatans prefer to amble over to their sewage-treatment plant to watch the egrets eating breakfast.

A leading proponent of the marsh system, Dr. Bob Gearheart, a sanitary engineer and professor at HSU, explains that the sewage originates in houses on the nearby hills. When Arcatans flush, gravity takes their wastewater to a conventional treatment plant on the edge of the bay, where it's screened and solids settle out. The effluent is piped to 50 acres of oxidation ponds, where algae work on the waste and more solids are removed. The wastewater then flows into two 2-1/2-acre man-made marshes planted with bulrush and cattail, where the sewage effluent is "polished" (given advanced wastewater treatment). Next it flows into 45 acres of marshes constructed by the city and the California Coastal Conservancy to help restore fish, shellfish, waterfowl, and other wildlife to the area. By the time it flows into Humboldt Bay, the effluent is cleaner than the water it meets there.

One big bonus of the system: The marshes do their work without generating an ounce of sludge! Another: HSU professor and aquatic biologist Dr. George Allen uses some of the wastewater to raise salmon and coastal cutthroat trout to help replenish local waters. And Arcata's new sewage treatment system has returned sorely needed wetlands to the Humboldt Bay environment. Total cost of the system, including planning and environmental studies and acquisition of some land: $514,600 (give or take several years of adroit politicking to get the go-ahead from state regulators).

While Arcata's wetlands do only tertiary treatment, a number of other man-made marsh systems are doing more heavy-duty secondary treatment.

• ELEPHANT EARS AND CANNA LILIES

Since his first forays into wastewater treatment with water hyacinths, Bill Wolverton has designed a new generation of natural treatment technologies called "microbial rock filter marsh systems," or rock marshes. Engineers also call them "vegetated submerged bed systems" because the wastewater flows discreetly through the rocks below the surface.

Dr. Wolverton's first rock marsh was a simple system designed to purify discharge from his septic tank. Septic tanks usually discharge into an underground leach field, where organisms in the soil break down pollutants. The stuff coming out of many septic tanks in his area of east Louisiana and west Mississippi was either percolating quickly through sandy coastal soils into the groundwater, or not draining fast enough through dense clay soils, bubbling up, and causing odor problems.

To demonstrate that there is a workable alternative to the conventional leach field, Dr. Wolverton dug a shallow ditch, lined it with plastic, filled it with stones, and added wetland plants. Partially treated wastewater flows from the septic tank through the rock marsh, providing water and nutrients for the plants. As sewage-eating microorganisms grow on both the rocks and the plant roots, the system is very efficient. About 20 of these backyard rock marshes, which measure about 3' X 7', are also treating septic-tank effluent to secondary standards in Alexandria, Louisiana. Dr. Wolverton says similar rock marshes can work for schools, motels, office complexes, even entire cities.

In fact, he recently designed such a rock-marsh system for a mobile-home park in Pearlington, Mississippi. But instead of any old wetland plant, this system is using ornamental plants like water iris, elephant ears, and canna lilies. The sewage treatment "plant" can treat 10,000 gallons of wastewater a day from 28 trailers, and looks more like a flowerbed. (See page 27.)

Bill Wolverton says his wife took one look at the system, compared it with their own rock marsh, and said, "Get these weeds outta here and get me some of those flowers." His ornamental rock marsh systems apparently have that effect on others, too. Wastewater afficionados from around the world come to the tiny trailer park in Pearlington to get a load of all the pretty flowers.

Denham Springs, population 20,000, in southwest Louisiana near Baton Rouge, recently invested in a rock marsh on a massive scale. The city's wastewater is partially treated in two 40-acre ponds, then flows through three five-acre cells planted mostly with canna lilies. In summer, the place looks like a flower farm, but it's designed to treat 3 million gallons of sewage a day.

Bill Wolverton estimates that the city has saved $1 million dollars in initial construction costs and will save $60,000 a year on operation and maintenance. (Maintenance consists mostly of removing the dead plant tops in spring before new shoots start poking up.) Dr. Wolverton, who recently retired from NASA and now has his own consulting firm, Wolverton Environmental Services, has a number of rock marsh systems in the works. Other wastewater experts told me that if tests substantiate Bill Wolverton's high hopes for these systems, marsh-ecology sewage treatment will get a real shot in the arm.

John C. Stennis Space Center

In Louisiana's Denham Springs rock marsh, canna lilies, shown soon after planting, treat three million gallons of sewage a day. The wastewater flows discreetly below the surface.

• ECOLOGICAL ENGINEERING

"Five years ago, I began to realize the very essence of what makes New England so beautiful was being destroyed," said Dr. John Todd, inventor of an ecologically engineered sewage treatment system — make that wastewater *restoration* system — called solar aquatics. The occasion was the July 11, 1989, opening of a solar-aquatic research facility in Providence, Rhode Island.

"Thousands of gallons of toxic chemicals are dumped into our waterways every day, ravaging our drinking water, our lakes, and our streams. I knew there had to be a non-chemical way to transform the polluted, toxic waste back into pure water, so I started studying the lessons of nature to find a way. The result is here before you...."

While Bob Gearheart, Bill Wolverton, and other sewage-treatment pioneers have figured out how to make natural approaches work for small communities in mostly mild climates with lots of spare land for the man-made marshes, John Todd's solar aquatics technology offers hope for Northerners, even Northerners who live in big cities.

In 1969, John Todd, an aquatic biologist, co-founded the New Alchemy Institute on Cape Cod, a center of hands-on environmentalism. Dr. Todd's new solar aquatics facility is located in the industrial bowels of Providence, at the top of the Narragansett Bay. The 30'-X-120' greenhouse is sandwiched between the mountainous piles of scrap at the Pilot Metals Corp. and the sprawling Field's Point Wastewater Treatment Facility, New England's second-largest, which can provide secondary treatment for 91 million gallons of sewage a day. The experimental solar aquatics facility can purify up to 20,000 gallons of sewage a day, or about the amount from 150 households.

When you enter the facility, the last thing you think of is the stuff you flush down the toilet. Red geraniums hang from the greenhouse's steel rafters. A wooden walkway bisects four rows of translucent plastic silos, many with

CONVENTIONAL SEWAGE TREATMENT

The Same Old Sh--

The Red Hook Water Pollution Control Plant under construction.

Quick: When you flush your toilet, where does the sewage go? Chances are, it goes to a conventional treatment facility that works a lot like the Red Hook Water Pollution Control Plant.

Red Hook is where my daily deposits (and I don't mean bank deposits) and those from thousands of other apartments and businesses in downtown Brooklyn end up. The wastewater lingers at Red Hook for a few hours, then is discharged into the East River, where it continues on its way to the upper New York Bay and, eventually, the Atlantic. Red Hook is designed to treat 60 million gallons of this democratic slurry every day.

As soon as the *real* leftovers from yesterday's dinner enter the facility, they're greeted by huge bar screens which remove large solids (big wads of toilet paper, used tampons, and lots of used condoms). These items, usually about two cubic yards per day, are trucked to a landfill for disposal.

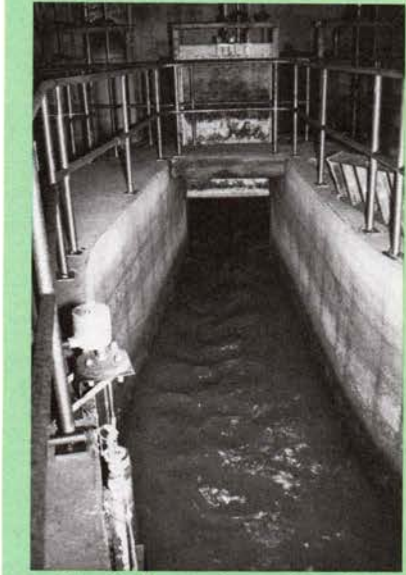
The screened sewage is then routed to four large, primary settling tanks, where it sits for a while until fecal matter and other solids settle on the bottom. This stuff is called "primary sludge," and it's pretty gross.

Secondary treatment at Red Hook is basically the same "activated sludge" process used at most conventional treatment plants. Liquid from the primary settling tanks flows into four deep aeration tanks. Diffused air supplied by gadgets called fine-bubble dome diffusers keeps millions of aerobic bacteria happily feeding on soluble organic matter and multiplying. This mass of reproducing microorganisms then flows into secondary settling tanks, where most of them settle to the bottom. By this time, they've consumed most of the tasty (to them) organic matter in the sewage, and the wait makes them ravenously hungry — hence the term "activated" sludge. Some are returned to the aeration tanks, where they serve as "seed" organisms for another round of treatment. The rest proceed unceremoniously to sludge digesters.

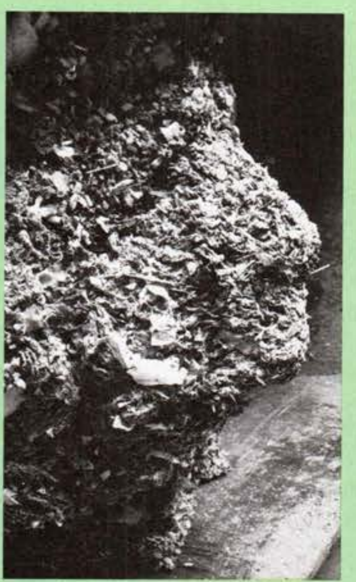
Meanwhile, the liquid, or "secondary effluent," continues on to another series of tanks, where it's disinfected with chlorine. By the time it's discharged into the East River, this effluent has been in the plant for seven or eight hours.

Before digestion, the sludge from the primary settling tanks is pumped to four big gizmos called Cyclone degritters, where sand, gravel, and the like (mostly from street runoff into New York's combined sanitary and street sewer system) are removed, then carted off to the landfill. Primary and secondary sludge meet in four 60-foot-wide "gravity thickeners," where more solids settle out, and liquid overflow gets pumped back to the beginning of the treatment process. The thickened sludge is pumped to six, 60-foot-wide, covered digesters, where anaerobic bacteria get their turn at decomposing the muck.

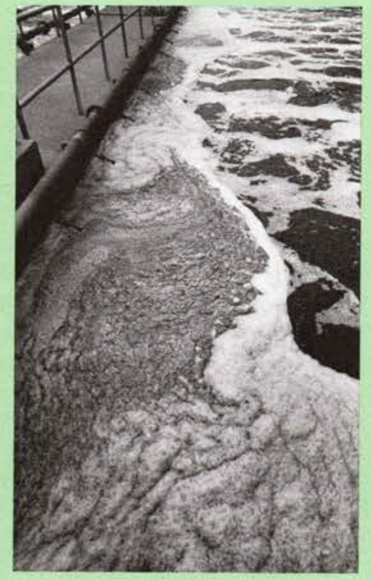
Photos: Marion Bernstein/NYC DEP



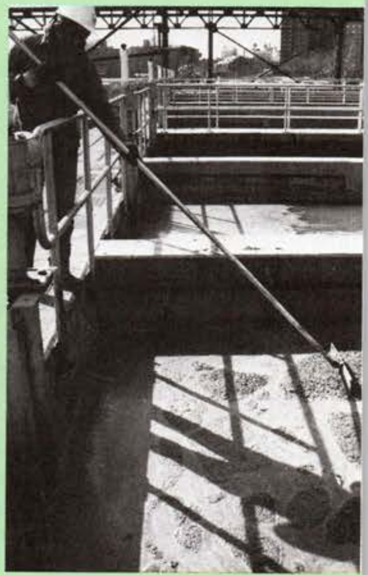
The "influent channel," where sewage enters Red Hook.



What comes out of the bar screens.



Scum on a primary settling tank.



Here, the scum is manually skimmed off the tank.

Digestion takes about 25 days. One of the by-products of sludge digestion is methane, or natural gas, which can provide about 20 percent of the energy needed to run the plant.

In New York City, digested sludge is loaded onto barges and gets dumped in the Atlantic. Congress recently banned ocean dumping of sludge, and New York City is scrambling to come up with an alternative. Whether it's dumped in the ocean or on land, 'or burned in incinerators, the mountains of sludge generated at sewage treatment plants have already reached crisis proportions in most cities. (Because most sludge is contaminated with toxic metals, only 20 percent ends up as fertilizer for farmland or as compost for garden use. Strictly enforcing industrial "pretreatment" programs, which require that certain industries remove metals and other toxins before discharging their wastewater into city sewage systems, would help. But this is a subject for a future issue.) Almost half of the operating cost of the typical treatment plant is for sludge treatment and disposal.

Metals aren't the only thing contaminating American sewage. Consider toxic chemicals. According to the federal Environmental Protection Agency, conventional sewage treatment plants do not remove a substantial portion of the toxic chemicals in wastewater. Then again, the agency doesn't require that they do. What's more, nitrogen and phosphorous are often present in the water leaving these facilities at levels that can harm aquatic life. Red Hook is state-of-the-art sewage treatment in New York City. But like the vast majority of municipal facilities in this country, it is not required to provide the advanced wastewater treatment that would remove these pollutants (see the accompanying article).

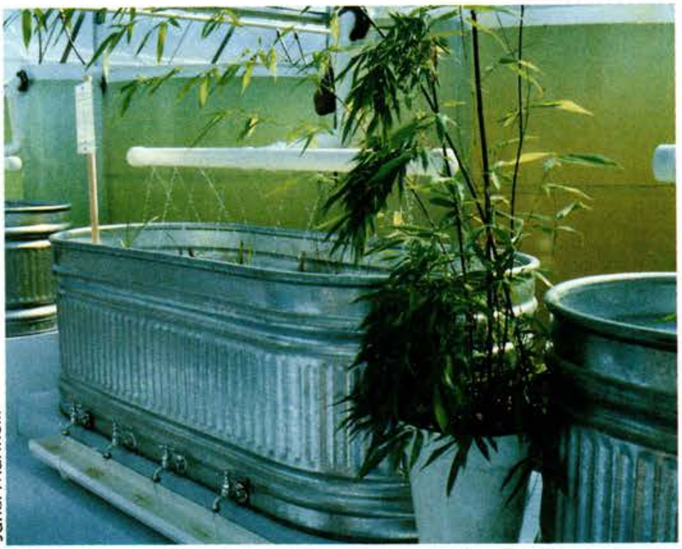
One more thing: Larry Robinson, the engineer who runs Red Hook and graciously escorted me around, keeps the plant running like a well-oiled machine. Thanks to Larry, the effluent that comes out of Red Hook is much cleaner than the stuff it meets in the East River. But the run-of-the-mill American treatment plant malfunctions often, sending partially treated sewage into the nearest waterway. *— Janet Marinelli*

Sludge digesters and gravity thickeners.

plants floating languidly on top.

Scott Sargert, the plant manager, explained how the process works. Each 1,300-gallon silo is a functioning ecosystem. Raw sewage flows into the "algae room," where bacteria found in any eutrophic pond begin digesting organic matter and converting toxic ammonia to nitrite and then nitrate — plant food. Duckweed, a prolific reproducer, consumes nitrates. More nitrate is removed by algae that adhere to the inside of the translucent tanks, where it's grazed upon by snails. Zooplankton feed on the algae suspended in the wastewater. Some silos are densely colonized by *Azolla*, a tiny water fern.

When the effluent enters the "clean room," it eventually will flow into four engineered marshes in plastic troughs lined with gravel and planted with bulrushes, cattails, and other species. Anaerobic bacteria in the gravel will convert excess nitrates into harmless nitrogen gas. Marsh plants will remove heavy metals and toxic chemicals.



Janet Marinelli

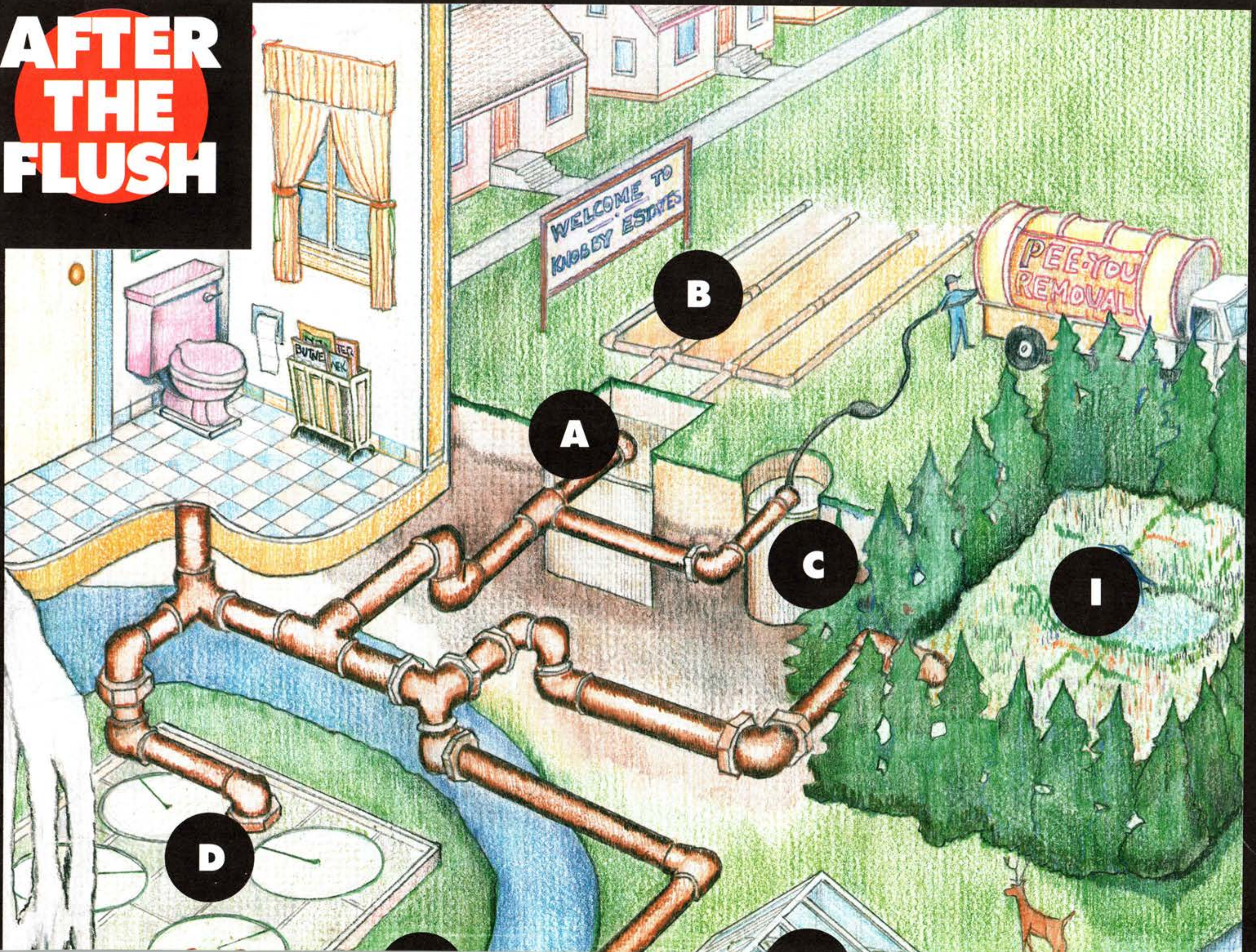
When the wastewater at the solar-aquatics facility in Providence, Rhode Island, flows into this final row of "polishing" marshes, planted with young marsh grasses, it's crystal clear.

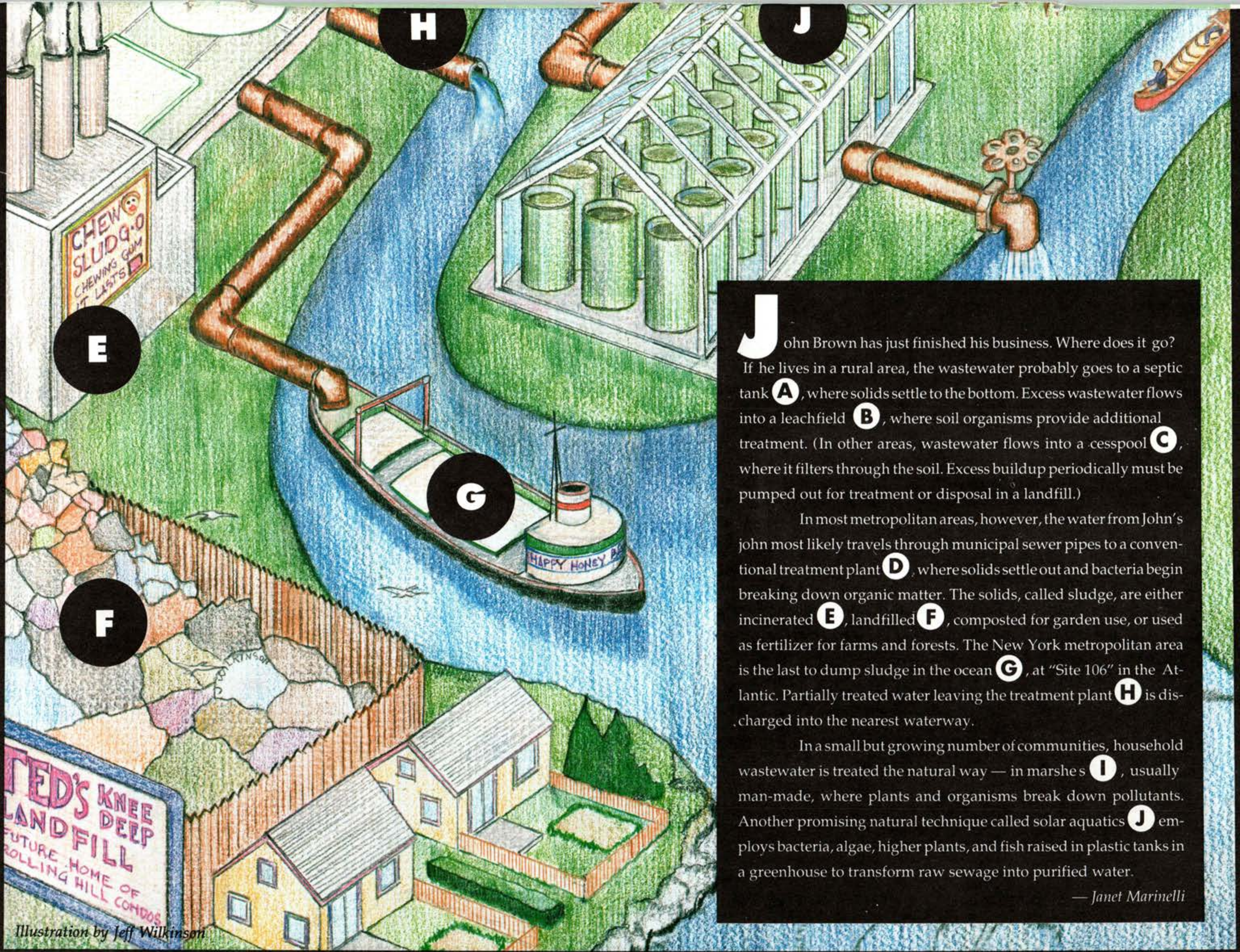
In more rows of plastic silos, striped bass graze on zooplankton. Water hyacinths remove more nutrients and take up toxic metals. In some silos, dense strands of green filamentous algae remove more nitrogen. Eventually, the clean room will be a huge hydroponic garden. Racks of commercial flowers and perhaps tree saplings will be grown on the surface of the plastic tanks.

When it flows from a final row of "polishing" marshes — shiny metal washtubs with stands of young marsh grasses — the effluent is crystal-clear and clean enough to drink, with one possible exception — viruses. Nobody in this country drinks effluent from a treatment plant. However, as a precaution, at most sewage treatment plants chlorine is used to kill viruses and other pathogens. Ultraviolet radiation is also used, but rarely, because it's more expensive. John Todd and colleagues hope to come up with a natural way to get rid of viruses.

Researchers will also be looking for a way to deal with the toxic metals in sewage. They couldn't have asked for a better place to look: The wastewater of Providence, referred to as the costume-jewelry capital of the world, is loaded with

AFTER THE FLUSH




H
J
CHEW-O SLUDG-O CHEWING GUM IT LASTS
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G
HAPPY HONEY B
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TED'S KNEE DEEP LANDFILL FUTURE HOME OF ROLLING HILL CONDOS

Illustration by Jeff Wilkinson

John Brown has just finished his business. Where does it go? If he lives in a rural area, the wastewater probably goes to a septic tank Ⓐ, where solids settle to the bottom. Excess wastewater flows into a leachfield Ⓑ, where soil organisms provide additional treatment. (In other areas, wastewater flows into a cesspool Ⓒ, where it filters through the soil. Excess buildup periodically must be pumped out for treatment or disposal in a landfill.)

In most metropolitan areas, however, the water from John's john most likely travels through municipal sewer pipes to a conventional treatment plant Ⓓ, where solids settle out and bacteria begin breaking down organic matter. The solids, called sludge, are either incinerated Ⓔ, landfilled Ⓕ, composted for garden use, or used as fertilizer for farms and forests. The New York metropolitan area is the last to dump sludge in the ocean Ⓖ, at "Site 106" in the Atlantic. Partially treated water leaving the treatment plant Ⓗ is discharged into the nearest waterway.

In a small but growing number of communities, household wastewater is treated the natural way — in marshes Ⓘ, usually man-made, where plants and organisms break down pollutants. Another promising natural technique called solar aquatics Ⓙ employs bacteria, algae, higher plants, and fish raised in plastic tanks in a greenhouse to transform raw sewage into purified water.

— *Janet Marinelli*

heavy metals. John Todd hopes to explore the possibility of using species of mosses that thrive at mine sites to accumulate metals to the point that they can be recycled by industry.

One of the biggest attractions of solar aquatics from a municipal official's point of view is its ability to transform sewage into purified water without generating ridiculous amounts of sludge. A small amount of sludge was produced at previous pilot facilities in Sugarbush, Vermont, where the wastewater of a ski resort was given the natural equivalent of tertiary treatment before discharge into a trout stream, and Harwich, Massachusetts, where septage, the stuff pumped out of septic tanks by "honeywagons," was also turned into high-quality water. A study by Nolte and Associates, a California-based engineering consulting firm, concluded that the Harwich facility produced "substantially less" sludge than a conventional treatment plant. It also noted that "collection, treatment, and disposal of sludge from the bottom of the tanks are design and cost items which must be addressed." Sludge is on the agenda at Providence. Half of the facility will soon be treating sludge from the treatment plant next door.

Harwich was so satisfied with its solar aquatics test facility that it has commissioned Ecological Engineering Associates, the company formed to commercialize the technology, to build a full-scale version. Dr. Todd was even able to totally remove 14 of the 15 toxic substances that the EPA has classified as worrisome "priority pollutants" from the septage, a truly vile slurry of restaurant greases, toxic industrial by-products, and hospital wastes that's 100 times more concentrated than sewage. The fifteenth, toluene, was 99.9 percent removed. The fish in Harwich's final tanks tested free of PCBs and dioxins, and contained lower levels of metals than their wild ocean counterparts.

According to John Todd, solar aquatics requires no more land than conventional sewage treatment. (Providence plant manager Scott Sargert pointed out that the greenhouse was designed to accommodate a double decker of plastic silos.) Dr. Todd also estimates that a solar-aquatic plant can provide advanced wastewater treatment at about two-thirds the cost of a conventional plant providing only secondary treatment. Revenue from sales of flowers, tree saplings, etc. could be a signficant source of *income*.

Dann Blackwood

At the Providence solar-aquatics facility, microorganisms, plants, and fish purify wastewater. The greenish cast is algae.

Richard W. Brown

At this solar aquatics plant in Sugarbush, Vermont, the wastewater of a ski resort was purified, then discharged into a trout stream.

John Todd's only real competition, as far as I know, is Dr. Bill Jewell, an agricultural engineer at Cornell University in Ithaca, New York. In his system, sewage is partially purified in tankfuls of anaerobic bacteria. A by-product of these bacteria is methane gas, which can be used to generate power. Effluent from the anaerobic tanks is piped into long, low troughs inside a greenhouse, where it's used to grow plants hydroponically. Dr. Jewell estimates his system costs substantially less to build than a conventional sewage-treatment plant, and could generate a respectable source of income from the sale of natural gas alone. A pilot-scale facility is currently treating 10,000 gallons a day of sewage in the Ithaca area.

• A DOSE OF REALITY

When he first started designing his marsh and aquatic sewage treatment systems, Bill Wolverton remembers, "Everybody said 'here comes that nut with a pocketful of plants who thinks he's gonna change the world.'" Now lots of other engineers are designing these systems, too.

This is heady stuff. Could marsh-ecology herald the dawn of a new age in sewage treatment, be further evidence of the growing environmental awareness that has sparked not only the tug-of-war between conventional and natural sewage treatment, but also between nuclear and solar energy, and garbage incineration and recycling, and chemical and organic gardening?

For a dose of reality, I called Bob Bastian of EPA's Office of Municipal Pollution Control and asked how enthusiastic the agency is about marsh-ecology sewage treatment systems. "How enthusiastic is EPA about anything?" he answered dryly. "We're not in the business of promotion." Hmm. In 1988 the agency did publish a design manual for engineers interested in marsh and aquatic treatment systems.

Before I was finished researching this story, I spoke to many of the wastewater engineers designing and promoting these systems. We're not talking about plant worshippers. Most of them are hard-nosed skeptics. Pio Lombardo of the international engineering consulting firm Dames & Moore gave me the following no-nonsense answer when I asked

COMPARING THE TECHNOLOGIES

TYPE	ADVANTAGES	LIMITATIONS	BEST FOR
Conventional Sewage Treatment	Old technology, so engineers know exactly what to expect; doesn't require a lot of land.	Expensive; cranky; "shock loadings" or sudden inflows of toxics (usually from industry) often upset the bacterial balance, sending barely treated sewage into the local waterway; energy-intensive; advanced wastewater treatment often involves the use of toxic chemicals; hard to site (would you want a sewage plant next door?); sludge disposal is a major headache.	Big cities.
Man-Made Marshes (with open water)	Cheap; no sludge; good removal of nitrogen, toxic chemicals, and trace organics; can survive toxic overload better than conventional treatment; can be used for secondary or advanced treatment without chemicals or a lot of energy; wastewater can be used to restore wetlands habitat; nice to look at.	Require lots of land; plants may have to be harvested occasionally.	Small communities with a lot of land.
Man-Made "Rock Marshes" (submerged flow systems)	Efficient; can include showy ornamental plants; routine harvesting of plants unnecessary.	Rocks can be expensive; not as extensively tested as open-water marshes.	Small communities with extra land.
Solar Aquatics	Virtually purifies water; effective in cold climates; creates substantially less sludge than conventional treatment; can treat extremely concentrated wastes such as septage; may cost significantly less than conventional treatment; sewage is treated as a resource, not as a waste; produces potentially valuable plants and fish; nice to look at; requires less land than marshes.	Leading-edge technology not as extensively tested as the other systems; requires a different kind of expertise to operate; the greenhouse is an added cost and must be heated in winter.	Communities that have to meet stringent water-quality requirements; communities that have a septage problem; could prove to be a natural alternative for land-short cities.

why man-made marshes are the hottest thing in wastewater engineering: "They're simple to build. They're simple to operate. They're cost-competitive. And they work."

The cost factor should not be underestimated. The era of outright federal grants for sewage treatment is over, and unless Congress changes its mind (unlikely in this age of Gramm-Rudman budget control), state and local governments will be footing most of the bill from now on.

Marsh-ecology sewage treatment already makes economic sense in many small communities that need to improve their sewage treatment systems or build them from scratch. Some day in the not-too-distant future, solar aquatics and similar leading-edge technologies could be helping even larger cities achieve tertiary treatment or deal with sludge.

But don't hold your breath quite yet. Many municipalities are still struggling to achieve or maintain systems that can reliably guarantee effluent that's treated to the *secondary* level. Many older cities are scrambling to fund improvements to antiquated combined sewer systems, which send raw sewage overflowing into waterways during rainstorms. Consequently, municipal officials aren't exactly welcoming tertiary treatment with open arms.

But advanced treatment *will* become the standard. And unlike conventional advanced treatment, which generally requires one remedy for nitrogen pollution, another for phosphorus, etc., cost-effective marsh and aquatic systems can remove nutrients in just one step, *and* remove heavy metals *and* pesticides *and* industrial toxins — all of which has to be done if we're ever going to restore ravished fisheries and stop the bioaccumulation of toxins in aquatic food chains, and in our own bodies.

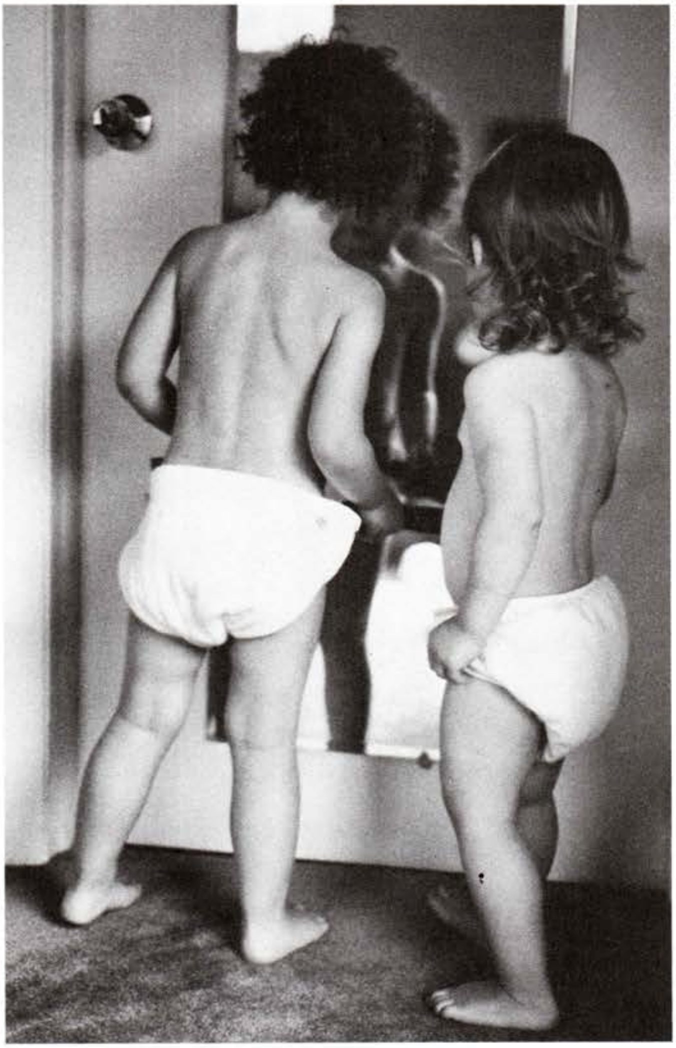
Richard W. Brown

Dr. John Todd at his experimental solar-aquatics facility in Harwich, Massachusetts, which turned septage into high-quality water.

DIAPER HYPE

We've read about cotton, disposables, degradables, and recyclables. Well, get a load of this, folks: Diapers are garbage unless they're cloth.

by Francesca Lyman



Photos: James R. LaBelle

Eskimo mommies wrapped their babies' bottoms in peat moss. Plains Indian tribes used animal skins. In old Europe women knit wool flannel pants. And only one generation ago, we spent our infancies clad in cotton cloth.

Then came the throwaway diaper, born in the late 1950s, which promised to free women from motherhood's most drudging chore. By the '70s, the disposable had cornered the market. So greatly did it change mothers' routines that the disposable diaper was featured several years ago in a Smithsonian Institution exhibit of American products and services that have "revolutionized our lives," alongside the Pill, antibiotics, smoke detectors, and shopping malls. Some observers of modern culture regard the advent of disposable diapers as a primary reason more women have been able to work outside the home. On the other hand, the disposable diaper, which will lie around for centuries, has become *the* symbol of the garbage crisis we're leaving for our children.

There's no doubt that the popularity of single-use diapers has soared during the past 30 years. By one industry estimate, when Pampers were introduced in 1961, disposable diapers accounted for less than one percent of all diaper changes; they now account for nearly 85 percent. Once considered an occasional luxury item, the disposable diaper is sold as an indispensable household article. Their handiness has made them into a $3.5 billion business; and a New York marketing consultant has called disposables the most dynamic new product category in consumer marketing history.

As miraculous as they may seem, however, disposable diapers, we now know, are becoming an increasingly serious garbage problem. Carl Lehrburger, solid-waste expert and author of a study for the National Association of Diaper Services, *"Diapers in the Waste Stream,"* bluntly concluded, "Single-use diapers should not be going to landfills." According to industry estimates, there are some 16 billion disposable diapers, made of woven cellulose and polyethylene plastic backings, buried in landfills each year. By weight,

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Francesca Lyman is an environmental writer and mother of a one-year-old cloth-diaper wearer. Her forthcoming book, The Greenhouse Trap, *will be published by Beacon Press this Spring.*

they represent about 12,300 tons of waste a day.

Diapers are by no means the only landfill problem — they represent, in fact, less than two percent of the total amount of waste in landfills. (Although that figure may sound small, environmentalists argue that it's a large percentage for any one single item.) What's significant is that this one item could be easily reduced without the organized effort of, say, newspaper or beverage-container recycling.

• THE SEARCH FOR THE ENVIRONMENTAL DIAPER

Since throwaway diapers made their debut, diaper companies have been battling to find the most sophisticated diaper design possible. Plasticized diapers have evolved from unwieldy pads that often shredded when pinned into the high-tech products they are today, with fitted waistbands, reclosable adhesive flaps, and cartoon-character imprints. Now, with landfills closing and protests mounting, we find ourselves in a new era of diaper wars, as manufacturers attempt to put a pro-ecology face on their products.

Touting its product as the "biodegradable, nonchemical" alternative, RMED International Corporation of Tulsa, Oklahoma, started marketing TenderCare diapers last year by mail order and through health food stores. During the past year the company has seen its business double. RMED claims that the plastic backing on its diapers contains a cornstarch derivative that will help the product break down into water and carbon dioxide in two to five years. "We're changing the world, one diaper at a time," reads their slogan.

But this semi-biodegradable diaper, along with a few others like it, has taken some trashing — with good reason. Environmentalists as well as the biggest disposable-diaper makers, Procter & Gamble and Kimberly-Clark, say claims made by manufacturers of biodegradables are unsubstantiated because crowded landfills lack the water and oxygen necessary for degradation to occur at such a rate. Jeanne Wirka, a solid-waste expert at the Environmental Action Foundation in Washington, D.C., contends "there's no evidence that the diapers can decompose any more quickly than conventional throwaways." Also, biodegradable disposables consume as much paper and plastic as do the major brands. (According to one study, 1,000,265,000 tons of wood pulp from trees and 75,000 metric tons of plastic are used every year to make disposable diapers in the United States alone.) So it would seem that these new products won't reduce the volume of solid waste. (And of course, they do nothing to get fecal matter out of the landfill and into the sewage treatment facilities where it belongs.)

There are some 16 billion diapers, made of woven cellulose and polyethylene, buried in landfills each year. By weight, they represent 12,300 tons of waste a day.

In the meantime, Procter & Gamble, which sells $1.65 billion worth of disposables per year, has underwritten a small pilot program to see if the paper pulp, plastic, and chemicals in their disposables can be recycled. In so doing, says their public relations division, they will be "redefining the concept of disposable" by turning the material into a resource.

Procter & Gamble has teamed up with the Rabanco Corporation, a Seattle recycling company, to pick up disposable diapers at curbside from as many as 1,000 families, deliver the collected diapers to the recycling center, separate the plastic from the paper pulp and sanitize its components, and finally take the reclaimed materials from the recycled diapers to produce products such as plastic flowerpots, drywall backing, and computer paper.

Recycling is certainly a laudable goal. But the economics of separating out component parts of plasticized diapers and finding markets for the paper, plastic, and even absorbent chemicals may kill the idea. There are doubtless, consumers who support the experiment. Still, the cost of collecting, separating, and recycling plasticized diapers would most likely fall on the taxpayer, because Procter & Gamble's financial support may end with the pilot project. Mr. Lehrburger estimates that the cost of recycling plasticized diapers would be much higher than the cost of the diaper.

A better alternative than recycling, Mr. Lehrburger says, would be to have companies develop a sewer-safe flushable diaper. Interestingly enough, it's only been a few years since Procter & Gamble discontinued a Pampers that was partially flushable. Consumers were instructed to separate the absorbant paper liner, which could be flushed, and discard only the plastic backsheet. The company now says that's not the way to go. "There are markets for recycling the materials," says a spokesman, "rather than flushing them away." [Ed. note: Flushable diapers aren't compatible with the water-conserving, ultra-low-flush toilets that may be standard in the future. See *Toilets,* page 16.]

Composting diapers is another option being considered by Procter & Gamble. The corporation is working with a composting company in St. Cloud, Minnesota, to turn diaper parts into humus. Eighty-seven percent of the diaper is comprised of cellulose, and is compostable. Composting may be a workable option but, as Mr. Lehrburger reminds us, "What we really need are the composting facilities to do it."

• THE CASE FOR COTTON

The *obvious* alternative to disposables of any sort? Cotton diapers, those soft squares of cloth that used to be held together with Donald Duck pins, can be used again and again and pose no garbage problem. They're also the most economically sound alternative — for both individual parents *and* for society as a whole. With single-use diapers costing about 22¢ a piece (according to Mr. Lehrburger), biodegradables 26¢ to 39¢ a piece, cloth diapers 13¢ a piece when washed at home and 15¢ when laundered at a service, cotton ends up being the bargain.* As Carl Lehrburger warns us, "We have been sold on the idea of disposability without full recognition of the social costs associated with convenience." He says that disposing of "disposables" costs us more than $300 million each year.

So cotton diapers, far less resource-intensive than disposables, make good sense. But there's still reluctance among new parents to convert to cloth. *Eighty-five percent of*

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* In determining these figures, Mr. Lehrburger considered the cost of water, detergent, electricity, and the initial investment for a washer and dryer. These calculations don't take into account that some parents change cloth diapers up to twice as often as other parents using disposable diapers.

parents use disposable diapers all the time. Ninety-seven percent of them use disposables part-time. Thanks to disposables' high-tech moisture retention, and thanks to powerful marketing campaigns by manufacturers of disposables, cloth is often considered to be less effective, less sanitary, and less convenient for the diaper-changer. "The reason disposables are so popular is their superior performance," says Tina Barry, a spokesperson for Kimberly-Clark. "They're more convenient, so there are a lot of parents out there who are reluctant to stop using them."

While the companies that produce disposables argue that paper keeps a baby drier, cloth advocates counter that the plastic backing prevents the skin from getting air. "Cotton is a natural product," says Jack Shiffert of the National Association of Diaper Services in Philadelphia. "It breathes, and air can circulate."

The trend toward natural childbirth, breast-feeding, and better nutrition includes the cloth-is-better-for-baby idea, says Mr. Shiffert. "The pendulum is now swinging away from people's sense of their *own* conveniences," says Jane Martin of Natural Baby Company in Pennington, New Jersey, a mail-order baby-products company, "to an awareness of the health and comfort of the *baby*."

• CLOTH vs. DISPOSABLES: THE HEALTH QUESTION

Many parents don't flush baby poop down the toilet, even though diaper packages say to. So, almost three million tons of body waste end up in municipal landfills each year. Proponents of cloth diapers often note that the fecal matter which travels to landfills via disposable diapers may carry viruses that could threaten the health and safety of sanitation workers, and leach into groundwater.

...biodegradables are just "the latest gimmick with which to calm the consumer and befuddle the politician."

No one really knows if the health hazards are significant or not. Procter & Gamble notes that no scientific study has yet proven a connection between landfilled fecal matter and the spread of related disease. But the King County Nurses Association of Seattle sent a memo to physicians, nurses, and hospitals advocating that existing local health laws which forbid human excrement in residential garbage be enforced. Babies are effective carriers of 100 viruses, such as polio and hepatitis. Little research has been done on the hazards of virus leachates from landfills.

As to baby health, cloth champions also argue that disposables are more likely to cause diaper rash partly because of their tight fit and synthetic components. They cite a study by Montreal pediatrician Fred Weiner of one-month-old infants, which showed that the group wearing Pampers developed more rashes. "The plasticized disposable diaper, no doubt, has its place for short-term or intermittent use, such as traveling," wrote the doctor. "Its shortcomings, however, should be recognized.... Should a rash appear, a more pervious diaper should be substituted."

The big disposable makers, on the other hand, claim that their diapers are better because the paper pulp — especially with absorbent chemicals — can retain more liquid and "lock" urine away from a baby's skin. But neither Kimberly-Clark nor Procter & Gamble can cite studies, other than their own, which prove disposables lead to a lower incidence of diaper rash.

Yet the companies have worked hard to get medical endorsements. "Procter & Gamble has relied on platoons of medical professionals and scientists and day-care directors for help in developing, testing, and promoting the product," wrote the *Wall Street Journal* in 1986. The article describes how Procter & Gamble was able to secure the agreement of the National Association of Pediatric Nurse Associates and Practitioners (Nap-nap) to endorse their Ultra Pampers. But they failed to secure the endorsement of the more influential American Academy of Pediatrics. The company does have the endorsement of individual pediatricians.

For the most part, doctors and nurses have steered clear of the controversy. Some doctors are willing to state that it is generally healthier for baby to wear a loose-fitting diaper that allows air to circulate. "Perhaps there will be a time when cloth [is] advocated as medical advice," says Joyce Fischer, a pediatric nurse with Columbia Presbyterian Hospital in New York City. In her baby-care classes at the hospital, Ms. Fisher informs her students of their diaper options, but recommends getting a diaper service only if asked her personal opinion.

Another suspected cause of diaper rash is the superabsorbent chemical sodium polyacrylate found in the diaper's paper pulp. Each new-and-improved diaper has upped the ante in terms of absorbency. Initially diapers got fatter and more wadded with paper fluff; today they've gotten slimmer and more heavily pumped with superabsorbent, "wetness-slurping" chemicals. Manufacturers of disposables claim that sodium polyacrylate, the salt-based chemical that turns into a gel when in contact with liquid, keeps babies drier and cleaner.

Others disagree. One reason the superabsorbent is a problem, writes columnist Marian Tompson in *The People's Doctor Newsletter* of Evanston, Illinois, is that "because of the superabsorbency of the material and the expense of the diapers, mothers tend to leave urine-filled diapers on their babies for as long as possible. The result," she says, "is more diaper rash."

Ms. Tompson cites a letter by University of Rochester pediatrics professor Ruth Lawrence to the American Academy of Pediatrics, complaining, "With the introduction of new Ultra Pampers, we have seen an incredible outbreak of diaper rash. Male babies are particularly affected and we

HOW I DUMPED DISPOSABLES

Like most babies, mine didn't stay in his birthday suit for very long. Whisked from the delivery room, he was swaddled in flannel, and diapered in Pampers, Huggies, and Luvs.

No, I wasn't crazy about having my son Devin's bottom encased in plastic. I knew these products would neither pamper, luv, nor hug the Earth. I got a bad case of diaper guilt, which just kept getting worse. But hooked on the convenience of disposables, I kept putting off finding a cloth service.

I had to face the music one winter morning at a League of Women Voters Meeting on town recycling. The subject of diapers might never have come up, had my three-month-old not raised it himself with audible grunts and a seriously red face, choosing a pause in parliamentary procedure to do what babies do best. Then one woman asked the question of the hour, "What kind of diapers do you use?" "Not *disposables?*" Before she could say "shame on you" I ran through all the reasons I hadn't yet kicked the plastic habit. I had lots of excuses: the free Pampers that the hospital had given us in our take-home package, the stress of being a new mother, the lack of information on diaper services – there wasn't a single item about cloth services in the mounds of baby-related junk mail I'd received. But all of that really didn't matter. I knew I had to convert to cloth.

A cloth-diaper service turned out to be no further than the Yellow Pages. The cost, $11.99 for a batch of 60, was a bargain in comparison to the $6 per dozen I occasionally had to shell out for disposables. The big plusses were less trash and less rash.

Diapering hardly seems like something to romanticize, but it was nice to know that even if there was no milkman, there still existed a personalized service. The stork-chasing diaper-delivery man arrived with a big bucket in one hand and a bag of flannel nappies in the other. He held the baby while I wrote him a check.

Sure there were some problems at first. Finding plastic pants and safety pins took some doing; the salesgirl at CVS (one of the largest drugstore chains on the East Coast) *didn't know what they were.* Another catch was that Devin stopped sleeping through the night. This tested my ardor, but when I weighed all the pros and cons I realized how easy using a service really was. It took only about 30 seconds to change each diaper. I was *not* tied to the house or kept from going on trips. And if I used a disposable in times of acute necessity, it wasn't the end of the world.

I actually began to like the routine. I liked the feel of cotton diapers and I liked the way they looked on Devin. They also gave him more freedom of movement. In some ways it began to seem *more* convenient – I didn't have to worry about replacing disposables: The service brings them and takes them away. Best of all, my diaper guilt is a distant memory.

— Francesca Lyman

have seen infants whose perineum and scrotal tissue just ooze blood. Because of the intolerance of these newborns for this product we have discontinued its use in our nursery." Pediatric journals have reported cases of sodium polyacrylate sticking to babies' genitals and passing through urine.

Rumblings of consumer dissatisfaction with chemical-laden diapers may be one reason for the success of the biodegradable diaper TenderCare. It bills itself as the first "non-chemical" diaper, targeting people fearful of unknown chemicals. "We feel it's important for children not to be exposed to chemicals that haven't undergone long-term testing," says Suzanne Shelton-Foley of TenderCare.

• THE CONVENIENCE QUESTION

Now, the toughest argument for cloth advocates: that cloth isn't as convenient as disposables. Cloth-lovers believe that making the switch just means rethinking convenience. "Looked at from the diaper-changer's point of view," writes Jeanne Wirka in *Environmental Action* magazine, "this factor really ends up in more of a tie. Yes, cloth diapers have to be washed, but not if you get a diaper service. And though most moms and dads don't do it — you're supposed to rinse out baby poop from the throwaway before trashing it."

On the one hand, cloth diapers have to be lugged back from grandma's house or wherever one happens to be; on the other, a fresh supply of disposables has to be lugged home from the supermarket each week.

It's true that cloth diapers have to be changed slightly more often because they get more saturated than paper. Back-to-clothers feel it's worth it, however, since they like knowing that their baby isn't sitting in a paper wad emanating fumes of urine. "Wearing a disposable, your child doesn't pee any less often," says one convert. "Your child is still sitting in pee even if the paper diaper's not soaked."

The cloth contingent also likes to point out that cotton diapers aren't just reusable as diapers, but double as a million useful items — they're great for washing the car, for example, or dusting furniture, not to mention their myriad other uses around babies.

Diaper services have boomed during the past year. Jane Martin of the Natural Baby Company, whose product line includes nylon and wool diaper covers as well as old-fashioned diapers themselves, reports that her business has doubled its volume in the past half year.

Jack Shiffert of the National Association of Diaper Services says that "some services are up 30 to 35 percent. The phones have been ringing off the hook. Americans are switching over to cloth in droves, largely out of concern over the environment. Of course we've tried to take advantage of our position as the 'good guys.' But we haven't had to sell them — the issue has done it for us."

"When it comes to trying to convince people to switch, people are paralyzed by fears that are unfounded," says Jill McIntyre of Citizens for Cloth Diapers, a Boulder, Colorado, group. "They think of an endless round of soap buckets, laundry loads, and folding," she says, plus the added inconvenience of pins and plastic pants.

But many families are finding that doing an extra wash load really isn't that inconvenient, says Jill McIntyre.

Others have replaced plastic pants and pins with various types of diaper covers, most of them, like wool Biobottoms and nylon Nickys, using Velcro fasteners instead of pins.

"It's really not inconvenient at all, especially if you use a diaper service," says Ms. McIntyre. "It's as easy to take off a cloth diaper and throw it in a diaper bucket as it is to toss a disposable in the trash."

By hiring a diaper service, families are spared the job of laundering and aren't even required to soak or rinse diapers. They're simply asked to "shake what's shakable," says McIntyre.

One factor boosting sales for cloth diapers, especially on the East Coast, is added publicity. The issue has been helped along with a new marketing campaign devised by a public relations firm, Gaston & Gordon Associates Inc. of Flemington, N.J., who were hired by a local diaper service. They created Crusader Baby, an infant wearing a cloth diaper and a purple cape who helps spread the word. She appears on bumper stickers and even in person at shopping centers.

• REACHING INSTITUTIONS

Many agree that encouraging the use of cloth diapers over disposables makes sense socially — it saves landfill space, cuts down on litter, keeps human waste out of the garbage, and saves trees and petrochemical-based plastics. But day-care centers and hospitals almost universally use disposables. Some day-care centers even *require* that disposables be used, according to a June 1989 study by Environmental Action and the National Center for Policy Alternatives.

Jack Shiffert of the National Association of Diaper Services adds that day-care centers are often unenthusiastic about switching to cloth because it means extra responsibility for them. "Most day-care centers require that parents bring a box of Pampers with them," says Shiffert, "while those who switch have to set up a system and then bill parents for it."

"Many facilities," says Laurene Ellmers, director of the Elmtree day-care center in Boulder, "are under the misconception that they ought to use disposables — they think they're more sanitary." Actually, she says, regulations only require that centers have a clean supply of diapers on hand and that they ensure proper disposal of them.

Last year, Elmtree, along with 11 other Boulder-area day-care centers and one hospital, switched to cloth, a move spurred by Citizens for Cloth Diapers. The results, says Ms. Ellmers, have been very successful. As day-care centers have converted, so have the parents. The reverse, Ms. Ellmers speculates, may be happening. "As parents' awareness increases, they will demand cloth of their day-care centers."

Cloth diapers have to be washed, but not if you get a diaper service. Cloth diapers have to be lugged home from Grandma's, but disposables have to be lugged back from the supermarket.

Day-care centers that have switched say that it takes no longer to change a cloth diaper than a disposable diaper. Ellmers says that, while they had to add a diaper fee to their charge, they now no longer have the headache of keeping track of everybody's "own stack of disposables."

The National Association of Diaper Services is currently trying to enlist hospitals. General Hospital in Lancaster, Pennsylvania, a 566-bed facility that switched from disposables to cloth, reported that the change would bring them a 15 percent yearly savings.

• THE END OF DISPOSABLES

Whoever thought that shopping for baby diapers could be so complex? Most parents shop for the best buy and hardly consider such equations as post-processing cost. Linda Shearer, a former banker, now spends her time on basic home economics. "If you pardon my jargon, part of my reason for switching from disposables was that they weren't 'fully costed.' It doesn't include air and water pollution, litter, and garbage."

Given the landfill and other problems with so-called disposable diapers, *does it make sense to ban them altogether*? Some states think so. Nebraska became the first state to ban the sale of all diapers that aren't biodegradable by the year 1993 (a development which many attribute to the presence there of Archer Daniels Midland, the maker of the cornstarch-laden "degradable" plastic). Another bill has been introduced in New Jersey, a state widely known for its garbage-containment problems, banning the sale of hundreds of "disposable," plastic, non-reusable items.

As environmentalists have pointed out, encouraging biodegradables is not really a solution to the solid-waste crisis. Colin Isaacs, director of the Pollution Probe Foundation, wrote an editorial in Canada's *Probe Post* arguing that biodegradables are just "the latest gimmick with which to calm the consumer and befuddle the politician."

It's unlikely that most states will pass sweeping bans on disposables. However, as Jeanne Wirka and Jeffrey Tryens of the National Center for Policy Alternatives claim, regulating and restricting throwaways could discourage consumers from using them except for travel and special occasions, and encourage people to use cotton as a regular method. One disincentive would be to require labels on packages of throwaway diapers detailing their hidden hazards. New York State introduced legislation to require such labels. The Connecticut Assembly considered legislation to require manufacturers to place labels saying that soiled diapers contained viruses and microbes that could transmit diseases. Another approach is to tax makers of disposables and give tax credits to makers of reusables.

With garbage mounting, it's coming down to crunch time for landfills. Ultimately — and that's only a few years away for some states — it will reach the point where people can't get their garbage taken away. Then the misnomer "disposable" will finally become what some have always thought of it as — the non-disposable.

But if we wait that long for the tide to change, the tide will begin to move in on us — and our children. And future raiders of the lost ark who will sift through our civilization's remains won't find houses of dead kings, ancient treasures made of silver and gold, statues, and sacred objects. Instead they will find dirty diapers.

GREYWATER
FOR YOUR GARDEN

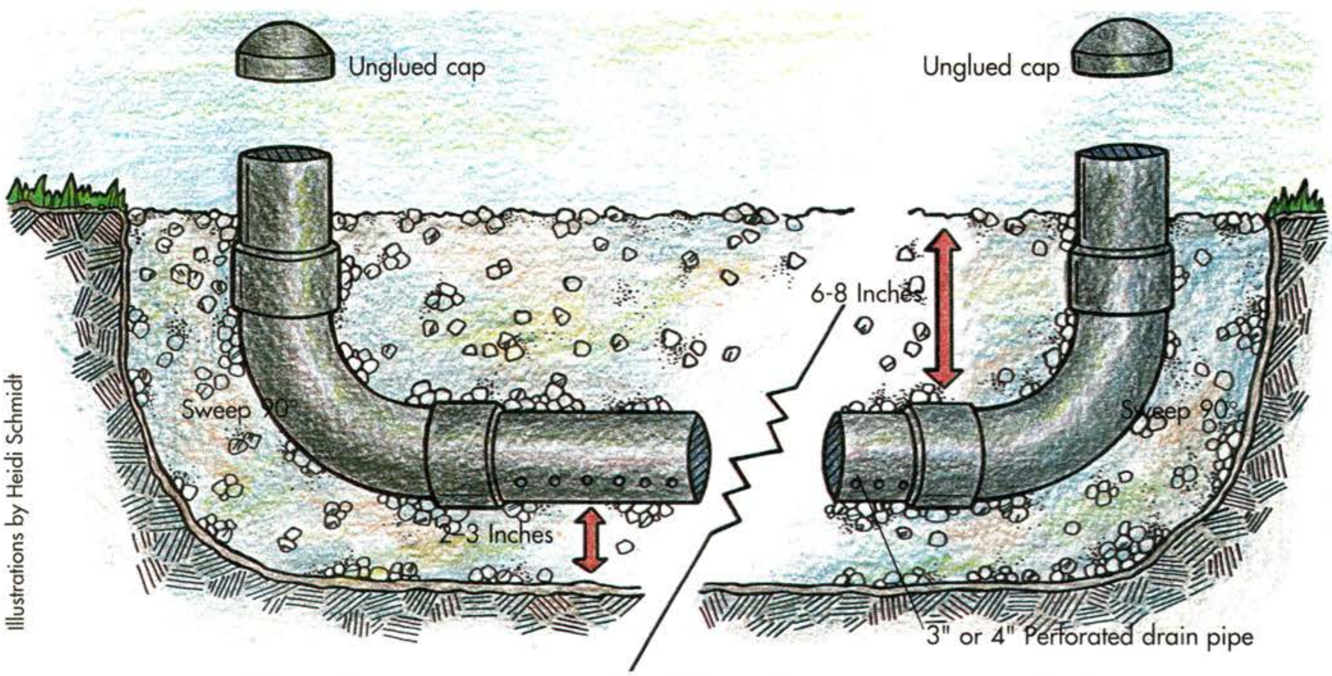
by Robert Kourik

What about the household water that doesn't *go down the toilet? Using this "greywater" is a sound idea whose time has come, not only during droughts, but also as a regular conservation measure. Greywater gardening saves freshwater and diverts relatively clean water away from overloaded sewage-treatment facilities.*

Only trouble is, it's kind of illegal.

Greywater is the so-called waste water from bathroom sinks, tubs, showers, and laundry rooms, and the rinse water from the kitchen. Rather than go down the sewer, it can easily be diverted to the garden for watering trees and ornamental plants. Ecologically speaking, it's a shame to irrigate with water that's pure enough to drink when your landscape plants can withstand – and even flourish – in much dirtier water.

But greywater use isn't appropriate for everybody. To weigh its usefulness and drawbacks for your situation, you have to understand a few things: what kind of garden it's best for; the legal implications of greywater use; what's involved in installing a simple system and what it'll cost. That's what this article is for.



Illustrations by Heidi Schmidt

Greywater can be routed to perforated underground pipes to create "mini-leachfields." (See page 44.)

• CAN I USE IT SAFELY?

Properly dispersed greywater is safe, although never, of course, as "safe" as watering with chlorinated, sanitized city water. The soil's rich array of beneficial bacteria has an amazing capacity to filter and purify dirty water, if not too much is added to a given volume of soil at any one time.

If allowed to puddle up and stand, greywater will, like any kind of stagnant water, attract mosquitoes and smell bad. It can also attract flies and possibly rodents. The improper application of previously contaminated greywater can spread parasites, viruses, and bacteria, with worst-case examples being typhoid fever, dysentery, and infectious hepatitis. (If anyone in a greywater household were to come down with an infectious disease, it would be prudent to turn off the valve and direct all wastewater back to the sewer for treatment.) All of these scenarios can be avoided by proper distribution and a little attention.

Using greywater means *you* are the treatment facility. You're responsible, not some big bureaucracy. If you contaminate your water or misuse the system, you might get sick – but it's a long shot. Your rewards are water conservation, a more natural, sustainable ecology, money saved on your water bill, and a landscape that flourishes even during a drought. (Incidentally, the cost of a system installed by a do-it-yourselfer runs about $200-$275, or $300- $500 if you need a pump. Installed by a plumber, the cost would be about $2500, money that will eventually be paid back by lower water bills.)

Good Sources and Bad

The best greywater sources are bathroom tubs/showers and sinks. The laundry room comes next, even considering that fiber and lint make the water harder to filter. (An exception: Don't use water that was used to rinse or wash dirty diapers.) It would have to be some desperate drought for you to bother with the water from the kitchen sink, because the oil, fat, and grease from dishwashing makes kitchen water smelly and hard to filter, likely to clog distribution pipes, and more likely to breed disease or attract pests. Leave the kitchen drain connected to the sewer. (An exception: a double sink with two drain pipes. One side can be hooked up to the sewer or septic tank and receive all the greasy or cleanser-laden wastes, while the other side is plumbed to the greywater system and gets water used for rinsing dishes and vegetables.)

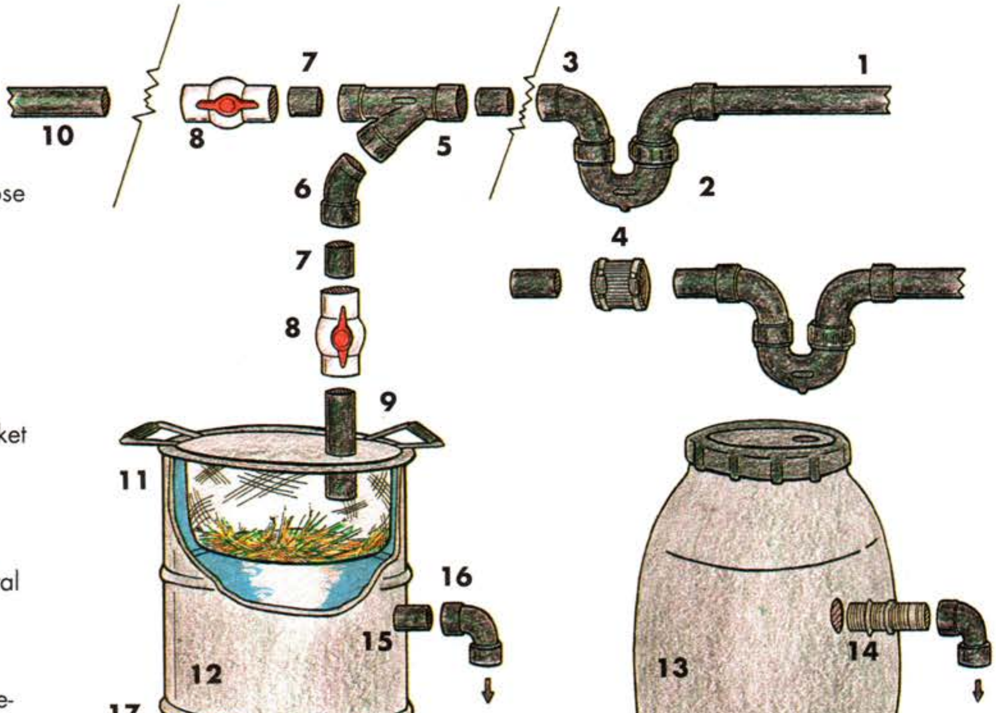
• HOW TO PLUMB A GREYWATER SYSTEM

It's easiest to install a greywater system in houses that are uphill from part or all of the landscape, and that have exposed plumbing in a basement or crawlspace.

Greywater systems are installed by (1) making cuts in your existing plumbing after the U-shaped traps and vents (see diagram on page 44); (2) installing a wye branch and ball-valves to divert water to either your greywater system or your standard plumbing; (3)constructing

GREYWATER DIVERSION

1. existing pipe from greywater source
2. trap
3. vent pipe
4. no-hub connector (with two hose clamps)
5. sanitary wye
6. street one-quarter bend
7. length of ABS pipe to drum
8. existing pipe to sewer/septic
9. length of ABS pipe to drum
10. existing pipe to sewer/septic
11. quarter-inch hardware cloth bucket (with or without straw)
12. metal drum
13. plastic/fiberglass drum
14. tank-nipple, metal
15. galvanized nipple welded to metal drum
16. threaded PVC 90 degrees
17. gate valve
18. nipple to pipe-thread to hose-thread adaptor



Household greywater may be diverted by a sanitary wye (#5) into reservoir drums constructed of metal (left) or plastic/fiberglass (right).

reservoirs to hold excess greywater.

This is all hypothetical, of course, because it's still illegal to have a greywater system. (We're just planning for a saner future, right?)

Tapping Into Pipes

Modern homes usually have pipes made of ABS plastic, which can easily be cut with a handsaw. ABS pipe fittings are merely glued together with ABS cement. (Pipe cements are relatively toxic, so use rubber gloves and work in a ventilated space.)

Older homes have metal pipes, making the first cuts more difficult. You'd use a hacksaw or an electric reciprocating saw with a metal-crunching blade to remove the first section of the pipe, and use a metal no-hub connector (with two hose clamps) to make the transition from the metal pipe to a short length of ABS pipe. From here on you can use the quick-glue fittings.

The two ball-valves allow for easy switching back and forth from the sewer to the greywater system. Gate-valves, although they cost perhaps 50% less than ball-valves, should be avoided, as they tend to become clogged with hair and lint and fail to shut off completely. The valves may be the most expensive part of the whole system but can also be the most vital, so don't go cheap on them. Metal valves are the only way to go, especially if you're putting in a permanent system.

All of these parts are found at either a very well-stocked hardware store or a retail plumbing outlet.

Backup Reservoirs

After the ball-valves are fitted, the discharge pipe is re-routed toward a drum. A big mistake I made during the last drought was to try to collect large amounts of greywater so I could irrigate a big area all at once. Collecting and holding greywater is an open invitation to the rampant potency of anaerobic bacteria – and gives new power to the word odiferous. The drums in the illustration at left are each meant to act primarily as a backup reservoir, in case the greywater comes in faster than the hose can distribute it. Your bathtub drains at a rate as high as 10 to 15 gallons per minute, but a garden hose can handle only three to four gallons per minute – thus the importance of a temporary reservoir.

The easiest drums to work with are metal ones with a bung on one round end (often the "top") and on the side, and with tops that are removable by loosening a large metal ring. Eventually, however, metal drums will rust through, potentially leaving you with a messy problem. The longest surviving drums are the plastic or fiberglass ones usually used for food; the tops are smaller on these so you will have to add a tank-nipple fitting to make a bung on the lower portion of the side. (Be sure to get used food-grade drums, not those used for petroleum products.) You can also use 35- to 55-gallon plastic garbage cans.

Screening the Used Water

You will also need to screen out large fibers and hair as the water enters the drum so the discharge hose won't clog. All the screens or filters I've tried left something to be desired: either the screen gets clogged and is hard to clean, or the filtering medium gets loose and clogs the discharge hose. So, I always try to design a system that doesn't put too much demand on the screen. If you use a three-quarter-

KEEP GREYWATER CLEAN

Once you've begun to use greywater, you have to be more careful about what goes down the drain. Many common household and bathroom cleansers are potentially rough on plants. You've got to go back to basics, and use only simple soaps and detergents (and elbow grease). Soaps are safer as they usually have less sodium than detergents. Avoid all modern detergents with claims of softening, whitening, and "enzymatic" powers, as well as bleaches in all forms.

Especially harmful are cleaners or detergents with boron, a substance that quickly can build up to toxic levels. Some scouring powders are simply soap and pumice or a gentle abrasive, and it's not hard to find an alternative to those with bleach, boron, or chlorine.

Baking soda is an acceptable substitute for most scouring. Use ammonia instead of bleach as a grease cutter or cleaner. Keep drains clean with occasional doses of boiling water, not caustic drain cleaners (which may eat your ABS pipes).Here's a list of cleansers and soaps considered safe for use with a greywater system:

ALL- PURPOSE CLEANSERS

Granny's Old-Fashioned Aloe Care
mail-order from Granny's Old Fashioned Products, Box 256, Arcadia, CA 91066 (818) 577-1825

Green
retail from Neo-Life Distributors; mail-order from Walnut Acres, Penns Creek, PA 17862 (800) 433-3998

SCRUBBING POWDERS

Bon Ami Cleaning Powder and Polishing Cleanser
retail at some supermarkets and hardward stores; mail-order from some natural products suppliers

LAUNDRY DETERGENTS

Ivory Snow Flakes
supermarket retail from Procter & Gamble

Green
mail-order from Walnut Acres; see above

Granny's Old-Fashioned Laundry Concentrate
mail-order; see above

LAUNDRY STARCH

Faultless Starch
supermarket retail from Bon Ami

BATHING SOAPS

Ivory
supermarket retail from Procter & Gamble

Kiss My Face Pure Olive Oil Soap
drugstore retail

Caswell-Massey Pure Castile Soap
boutique retail and various mail-order sources

Tom's Soaps
health-food stores and other retail from Tom's of Maine

Vegetable-Glycerin Soap
mail-order from The Body Shop, 45 Horsehill Rd., Cedar Knoll, NJ 07927 (800) 541-2535

WASHING SOAPS

Bon Ami Cleaning Cake
hardware-store non-trendy supermarket retail, and mail-order from various natural-products sources

Kirk's Original Coco Hardwater Castile Soap
supermarket retail from Procter & Gamble

Dr. Bonner's Pure Castile Soap
health-food store retail

inch hose, a large-orifice sprinkler or a perforated pipe set in gravel like a miniature septic tank leachline, you will need only the simplest of screens. The fiber or stainless-steel mesh filters that are used with drinking-water systems are not advised, as they are too fine and will clog solid in a matter of minutes.

The best screen I've found is a shallow basket made out of one-quarter-inch hardware cloth and hung inside the top of the drum. Be sure to make some handles for removing the basket, as it will need frequent cleaning. Make the basket shallow, but with its top below the top of the drum. Then, if the screen clogs, water will spill over the top of the basket into the drum, not all over your basement floor. Placing a layer of straw in the basket may make the hardware cloth easier to clean, but watch out for pieces of straw falling into the bottom of the drum. The dirty straw can be added to your compost pile.

Piping to the Landscape

With a gravity system, where the drum is located uphill from your thirsty plants, all you need is a quality three-quarter-inch hose for discharge. If you're using a metal drum, have a local welding shop attach a three-quarter-inch metal pipe nipple at the bottom of the drum wall and adapt this to garden hose threads.

With a plastic garbage can or drum, drill a hole near the bottom with a holesaw bit, then attach a tank nipple and a three-quarter-inch garden hose fitting.

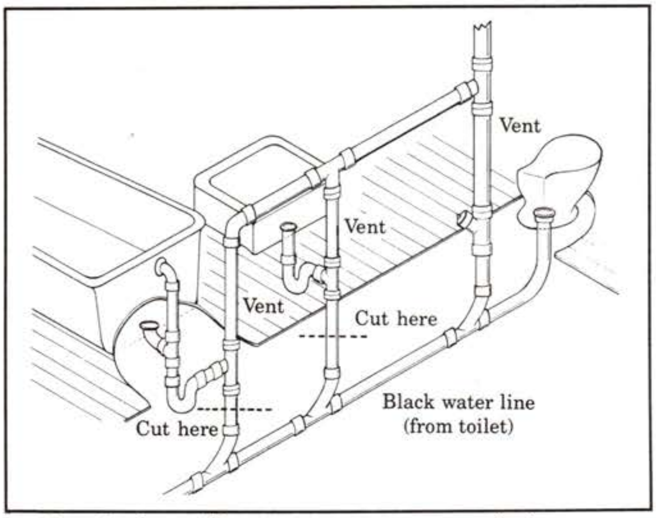
Don't try to use greywater with any kind of drip irrigation equipment, as it'll clog very quickly. It would be far too expensive to filter greywater enough to ever consider using it in conjunction with drip irrigation.

To Pump or Not to Pump

If the landscape you need to water is above the level of the only possible location for the drum, you'll need to pump the water.

Pumps, by their very electrical and mechanical nature, conjure up a kind of Murphy's Law of plumbing. With broken sewers, you just call up the Department of Public Works and complain. With broken greywater systems, there's nobody to yell at but yourself. If a pumped greywater system is your only option, this extra cost and maintenance must be considered.

If you do opt for pumping, in most cases a sump pump is all you'll need. Don't buy a pump unless the manufacturer's specifications match or exceed your needs. Make sure the gallons-per-minute (gpm) capacity is greater than 10 gpm. Another essential piece of hardware is a check-valve, which is installed between the pump and the hose running to the landscape. Without a check-valve, the water draining back into the drum would activate the sump pump and this cycle would be repeated forever.



To begin installing a greywater unit in a conventional household plumbing system, cut into existing pipe *after* both the vent and the U-shaped trap.

• DISTRIBUTION IN THE LANDSCAPE

There are two ways to disperse the greywater – via perforated pipe or by sprinkler. (Remember, drip irrigation is out.) The safest way is through a perforated pipe buried slightly below ground in a trench filled with gravel, like a small septic leachline. Use three- or four-inch rigid white styrene drainpipe with two rows of holes closely spaced down the length of the pipe. The pipe, which comes in ten-foot lengths, is sold at landscape supply and plumbing companies and some hardware and lumber stores. You can't put any of these 10-foot perforated lengths of pipe together in succession because greywater will not travel very far or evenly disperse through the holes. Keep each mini-leachfield to a separate 10-foot length, but construct a number of them at different places in the landscape where there are plantings or where you intend to plant.

The best greywater systems allow the soil to dry out between irrigations. By dividing these mini-leachfields into 10-foot segments, you can rotate the hose from one to the other and allow the soil to dry out and recover.

Glue a sweep 90 fitting (see illustration page 41) onto each end of a 10-foot section of pipe and add enough pipe to reach from the bottom of the trench to four to six inches above ground. The opening at the high end of the buried pipe is where you will place the greywater hose. Dig a trench 12 to 18 inches deep and five to 12 inches wide, and place each 10-foot section of pipe in a shallow trench with several inches of one-to two-inch crushed rock gravel on the bottom. Make sure that the pipe is close to level, with a drop of less than one inch per ten feet of pipe. The double line of holes should be on the bottom side of the pipe. Now fill the trench to the soil's surface with gravel. Hand-fit an unglued cap onto each pipe sticking above ground to keep critters out. Should a mat of fibrous gunk start to clog the drainage holes, the curved sweep 90 fitting will allow you to put a snake into the pipes.

To use these mini-leachfields, simply remove the cap at the high end of the buried pipe and place the end of the hose down the vertical pipe. When a day or two's worth of greywater has gone into one pipe, move the hose to another field. Such rotation lets each pipe dry out to prevent a buildup of scum and allows the soil to dry.

If you have well water, make sure that the dispersed greywater is no closer to the well than your local authorities would allow a septic leachfield.

While not too costly, the installation of these mini-leachfields is definitely a back-breaking endeavor. There is an easier way to disperse greywater, but it's frankly not as

IF ONLY IT WERE LEGAL

The early summer of 1976 – smack in the middle of California's terrible drought – found me groveling in moist mud beneath a shockingly expensive home somewhere in a discreet town in Marin County. The task at hand? Figure out which pipes came from the kids' bathroom sinks and showers, plumb the greywater into a sump, and pipe it to a series of storage barrels from whence it could be pumped to the landscape. All considerations as to whether my semi-skilled plumbing job was legal or not were cast to the dry, dry winds by the owners, who told me, "Our landscape cost thousands of dollars and we don't want to lose it."

Fourteen years later, using greywater is still illegal. Virtually all health and safety codes define it as sewage, and specify that it must be disposed of through "an approved plumbing and sewage system." Beyond that, it is technically a violation of the federal Uniform Building Code for homeowners to redo any of their own plumbing without hiring a certified plumbing contractor – who is forbidden from violating the code and therefore cannot install a greywater irrigation system.

Legitimate health concerns are behind this, although the danger is remote if you follow common sense. (When greywater systems were introduced on properties in nothern California during the drought years, the state inspector monitoring those systems reported that "none of the homeowners who had systems got ill from gray water.")

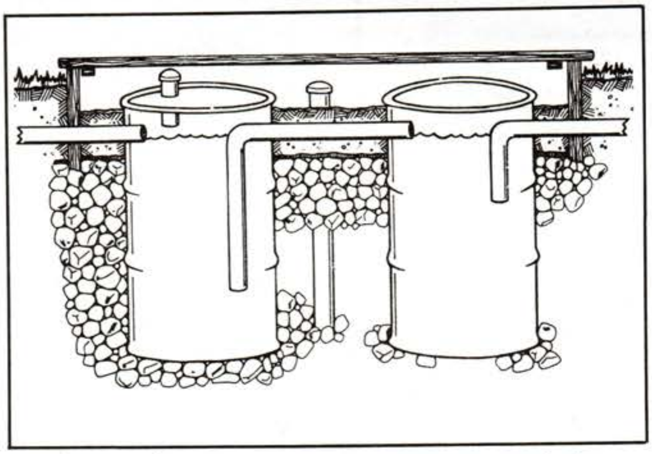
Of course, the hidden nature of the average home's plumbing makes violation of the Uniform Plumbing Code undetectable by all but an Orwellian task force. Many local governments politely ignore the technicalities of this particular law, and many of your neighbors may be purposely violating it. A permanent greywater system, with valves to switch back to the sewer, is best. But because it is technically illegal, such systems may cause problems when the house goes up for sale, and so the plumbing should be returned to its water-wasting status at that time.

Greywater makes sense, and laws can change. But I've run into problems just getting the word out. Deep-pockets fear of liability lawsuits has been a stronger urge than the fear of drought or environmental crisis about our water. I find that appalling. There is hope. Santa Barbara County (Calif.) was one of the first localities in the U.S. to legalize greywater use, in 1989. *– Robert Kourik*

safe and should be restricted to use in rural areas and places relatively free of human traffic. It is not an acceptable strategy for urban or suburban lots. The combination of sprinklers with large orifices and a spray that doesn't reach too high works nicely (it's the spray that adds an element of risk in the possible spread of pathogens in windblown droplets). Make sure the spray is close to the ground, that it puts out only big droplets of water, and that the wind isn't blowing hard when you're irrigating.

• WHAT TO WATER

Not all plants like greywater. The soaps and detergents in the water make it alkaline, and acid-loving plants such as citrus trees, azaleas, rhododendrons, violets, ferns, and most shade-loving plants should not receive greywater. (Use heavy mulching and limited drip irrigation to keep these plants happy during drought.)



With two drums, you can construct a miniature septic-tank system to fully treat your greywater. Greywater enters at upper left and exits at right-hand side of the right drum. The vertical pipe between the two drums is to check for leakage. The short pipe in the lid of the left drum is to view the scum level in the settling tank.

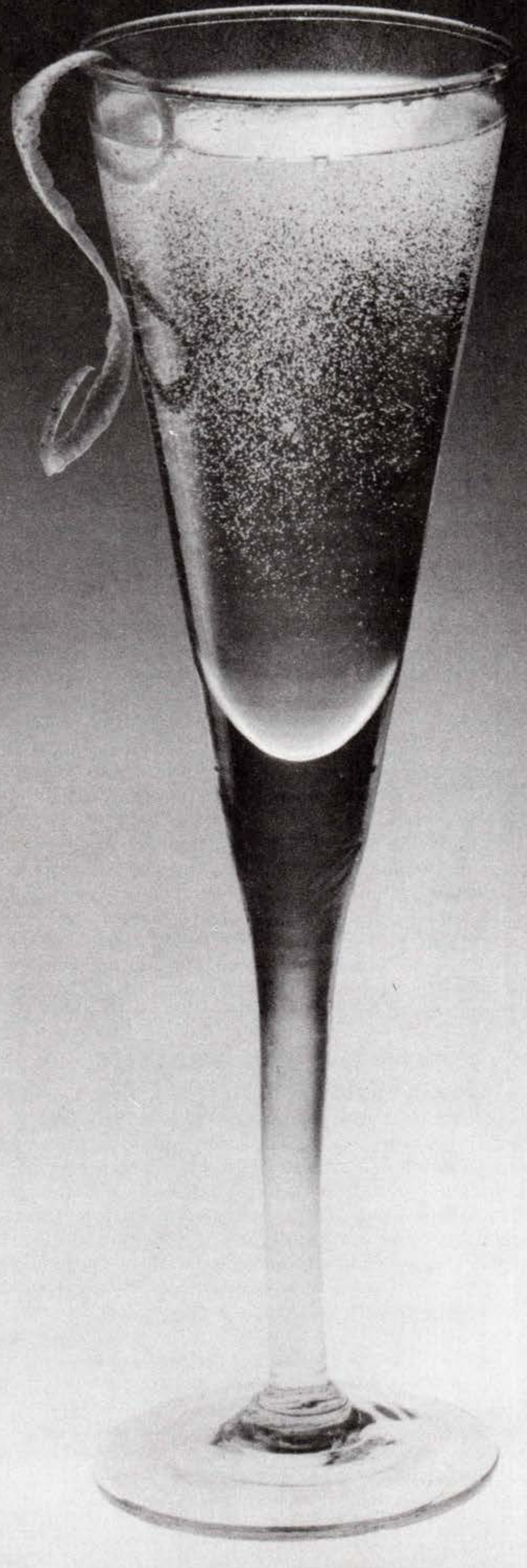
Using greywater on ornamental plants that don't require acid conditions is your safest bet. Most ornamental plants will tolerate or thrive on the phosphates in detergents, which act as fertilizers, providing they don't get overwatered. A rich, loamy soil can absorb up to one-quarter of a gallon of greywater per square foot per week. Or, every 400 square feet can handle 100 gallons of greywater per week. Sandy soils can handle more greywater and clay-ey soils much less.

Edible plants, in general, should not receive any greywater. Some people do use greywater on fruit and nut trees and tall crops such as corn and sunflowers where the edible part is well above the soil. Never use greywater on leafy greens, root crops, or low-growing vegetables like cabbage, squash, or beans. It is not recommended to use greywater on even tall edibles, but if you must, avoid using a sprinkler to keep spray drift from reaching up to the crop.

• KEEPING THE SOIL HEALTHY

The salts that might build up from greywater are, in my experience, seldom a problem and are leached away by each heavy rain. You can check for sodium buildup by doing a simple soil pH test. If the pH reading is over 7.5, your soil is building up too much sodium. Correct this by spreading two pounds of gypsum per 100 square feet once a month until the pH drops below 7.0. You can also dig in gypsum as a preventive measure at the rate of one pound per 100 square feet for every 20 gallons of daily greywater discharge. Sometimes, especially in clay-ey soil, the greywater may degrade the structure of the soil, making it stickier and less loamy. To counterbalance this, dig in plenty of compost or other organic matter.

Before the rainy season begins, or after each heavy summer rain, switch the valves so that the greywater goes into the sewer or septic tank. Do this because, after heavy rain, the ground is so saturated that any greywater diverted to the garden would run along the soil's surface and present a potential health hazard.



BOTTLED WATER: FADS and FACTS

by Ginia Bellafante

Rivaled only by pesto and Lycra, bottled water – particularly the imported bubbly variety – is likely to go down as the supertrend of the 1980s. The perfect complement to the fit lifestyle, it was the drink of the decade, guzzled in health clubs, boardrooms, and swanky restaurants. *Water bars* actually popped up in L.A. and New York. Elegant packaging and provocative ad campaigns bestowed upon bottled water the sex appeal of Dewars on the rocks or a glass of chardonnay. And it looks as though the fad will continue into the 1990s.

The International Bottled Water Association, or IBWA, is a trade group representing 85 to 90 percent of the domestic market and 35 major imported brands. They say Americans drink twice as much bottled water today as they did five years ago. There are currently 475 bottling plants in the U.S., representing about 600 brands. We spent about $2 billion on bottled water last year, making it the fastest growing segment of the entire American beverage industry.

While there's certainly a fad operating here, the truth is that most people don't buy bottled water for the cachet. They buy it because they are dissatisfied with the taste of their tap water or are afraid of what might be in it. William Deal, the executive vice president of the IBWA, notes that upscale imported waters comprise a relatively small part of the total market: Ninety-two percent of IBWA's members are domestic bottlers of non-carbonated water.

Whatever the variety, bottled water is pricey – about 700 times the cost of tap for domestic water and up to 3000 times the cost of tap for imported. The IBWA estimates that the average cost of one gallon of non-carbonated water is 94¢ and a gallon of carbonated averages $4.01.

Many of us shell out the cash, assuming bottled water is as pure as processors claim. But bottled water is by no means contaminant-free. In fact, studies of bottled water have found the same sort of contaminants typically found in tap water. The problem stems not so much from industry fraud as it does from the generally polluted condition of our ground and surface waters. Spotty inspection of bottled water plays a part, too. Whether poured from a bottle or drawn from a tap, *all* water comes from the same sources.

• BEHIND BAD WATER

Some bottlers cite history as assurance that their product is uncompromisingly clean. However, Perrier's boast that their water has been drawn from the same springs for over 120 years is no guarantee of anything. Perrier water may be fine, but we all know the world isn't the same place it was 120 years ago. Strains of bacteria, heavy metals, industrial chemicals, and pesticides have found their way into the lakes, streams, and aquifers[1] that provide us with drinking water. The notion of a "protected" source is an anachronism.

We have begun to grapple with the surface-water pollution resulting largely from the outflow generated by manufacturing plants, toxic waste dumps, and municipal sewage facilities. But to date, we know comparatively little about the more complex problem of groundwater contamination – pretty disheartening when you consider that 40% of the public water supplies in this country get their water from aquifers. Leachings from municipal landfills, underground gasoline storage tanks, hazardous-waste storage or disposal sites, as well as residues of chemical pesticides and fertilizers, are all responsible for the contamination; but we don't know much about the movement and behavior of these toxins once they reach aquifers. It is difficult even to predict whether or how much a particular chemical will leach: Topography, soil type, and the chemical characteristics of the substance must be considered. To make matters even more complicated, groundwater can travel into surface water and vice-versa. A study conducted by the Chesapeake Bay Foundation in Maryland found that 30% of the nitrogen in the bay could be attributed to groundwater flow.

Because rural areas are served almost exclusively by aquifers, the presence of agricultural chemicals in groundwater has caused even more concern in farm states. In 1988, the U.S. Environmental Protection Agency (EPA) reported that 74 pesticides had been found in the groundwater of 38 states. Recognizing the severity of the problem, the agency launched a two-year nationwide testing program of approximately 750 domestic and 600 public water-system wells for the existence of more than 100 particularly hazardous pesticides, pesticide metabolites, and nitrates. Some agricultural states, such as Iowa, where 59.9 million pounds of herbicides and insecticides were dispensed during the course of one year in the mid-1980s, consider the problem so serious that they've taken matters into their own hands, enacting legislation that increases fees on the sale of agricultural chemicals, and mandating that the extra money go into expanded groundwater monitoring programs as well as alternative-farming research.

Photos: Donald Betts/Horizon Photographics

• WHY SOME BAD WATER DOESN'T GET BETTER

Those of us who don't have the good fortune to live in states with tight water-purity controls must rely on the less-than-stringent EPA regulations that apply to municipal water supplies. These same federal regulations are the guidelines that have dictated the regulation of *bottled* water.

Under the Safe Drinking Water Act enacted in 1974 and amended again in 1986, the EPA is required to establish allowable limits, or Maximum Contaminant Levels (MCLs), for health-threatening substances typically found in public water supplies. These are termed primary standards. Secondary standards must also be set by the EPA for those substances that can affect the taste, odor, and appearance of the water. Although 700 different toxins were found in drinking water from 1974 to 1986, thus far the EPA has set primary standards for only 30 contaminants[2] including heavy metals, various organic and inorganic chemicals, volatile organics, bacterial and radiological contaminants. Environmentalists have been clamoring for an expansion of the primary -standards list and re-evaluation of currently regulated MCLs based on the most up-to-date toxicity data available. Under the 1986 amendments to the Safe Drinking Water Act, the EPA should have set standards for an additional 53 contaminants by 1989. The agency anticipates that it will propose those standards by the end of 1990. Twenty-five contaminants must then be added to the list every three years.

The EPA is also required to devise contaminant-testing schedules to which municipal facilities must comply. In addition, the EPA must outline community drinking-water treatment techniques. By 1993, communities dependent on unfiltered surface water will be forced to filter it in order to reduce the public-health risks posed by the presence of pathogens such as giardia, bacteria, and viruses. EPA regulations may be left to individual states or the EPA.

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[1] A subsurface layer of water-bearing sediment that contains the so-called groundwater.

[2] Some of the contaminants listed refer to a family or class of contaminants. For example, a number of strains of bacteria will fall under the bacteria category.

Regulation of bottled water sold across state lines falls under the auspices of the U.S. Food and Drug Administration (FDA). But again, certain states have set their own rigid standards for what's allowed in bottled water (see the list on page 49). Although the FDA is "compelled to consider" applying EPA's drinking-water standards to bottled water, it is not required to do so. Whenever the EPA issues new primary standards, the FDA has 180 days to either adopt those standards or publicly state reasons for not doing so.

The FDA currently requires bottlers to check for just 22 of the 30 contaminants considered primary standards by the EPA. This has credibility-seeking bottlers and safe-drinking-water advocates up in arms. Eight of the contaminants that go unmonitored by the FDA are in the volatile-organic chemical family. Vinyl chloride, a by-product of plastic and synthetic rubber manufacturing, and benzene are two examples of the sort of chemicals in this category. Five of the eight volatiles are known or suspected carcinogens. The EPA set standards for these chemicals in June of 1987, and the FDA should have responded by January 1988. But thus far no action has been taken. The IBWA claims it will file suit against the FDA if the federal agency does not adopt those standards for organics or give good reasons for rejecting them.

Pesticides are another potential problem in bottled water, which makes sense when you consider how much groundwater – an important source of the water – may be tainted with pesticides. In 1975, the EPA adopted MCLs for six different pesticides, and the FDA followed suit. But since then, four of those six pesticides have been banned or assigned restricted-use status. And many new pesticides have been registered with the EPA. For these reasons, critics argue that the list is outdated. Sandra Marquardt, a research specialist for Greenpeace's International Biocides Project and co-author of the Environmental Policy Institute study *Bottled Water: Sparkling Hype at Premium Price,* points out that two of the most toxic and widely used pesticides, the herbicide Alachlor and the insecticide Aldicarb (both found in ground and surface water) are not on the FDA list for bottle testing.

Other shortcomings in federal regulation of bottled water are infrequent contaminant-testing, sporadic inspection of processing plants, and loose labelling requirements. Specifically:

Bottlers are required to test water at the source and in final product form to ensure that it doesn't exceed established MCLs. That testing schedule is considered infrequent by people like Velma Smith, director of the groundwater protection project for the Environmental Policy Institute. Testing is ordered every one to four years, depending on the contaminant (except for bacteria, which is tested weekly).

Moreover, although plant operators must keep test records on file for two years, they are not required to submit them to the FDA. According to Allen Halper, assistant director of the division of Regulatory Guidance for the FDA, inspectors check plants every two or three years. The inspectors may or may not examine files when they make those visits.

Another hole in the regulations is that bottlers don't have to name their water source on labels. There are no legal definitions for all the different types of bottled water that exist, either (see the box on page 50). For example, any sort of water could bear the name "spring" water. Yet geologically, only water that flows from the ground to the earth's surface naturally is spring water.

More frequent reporting of test results might prevent substandard water from reaching store shelves. Independent lab studies of numerous bottled-water brands have come up with unsettling results. New York, Massachusetts, New Jersey, and California all have conducted studies focusing on specific aspects of bottled water quality in products sold within their states. In a 1987 New York Department of Health study, traces of volatile organic compounds were found in 52% of the 93 brands sampled. In Massachusetts, one product was found to contain twice the amount of lead allowable under federal law; another contained almost 100 times the permissible amount of gross alpha radiation. The New Jersey study found radiological contamination in all samples of imported water tested. Consumers Union sampled 50 products from the U.S. and abroad for all chemicals regulated by the federal government, in addition to a host of others. The study found that two imported brands had exceeded allowable limits for arsenic. When Consumers Union re-tested water, it was safe. Nevertheless, the studies tell us that bottled water is just as vulnerable to contamination as tap water.

• WHEN TO BUY BOTTLED WATER

There are, of course, instances when bottled water is a sound alternative to tap water. One of the most important reasons to buy bottled water is if your municipal water supply has a poor test record, for one or more chemicals. Test records are usually available through city or state departments of public health, water-quality agencies, and public utilities. A study conducted by the National Wildlife Federation, entitled *Danger on Tap,* concluded that 13 million people drank municipal water that violated EPA Maximum Contaminant Levels in 1988.

A frequent problem in community water supplies is the presence of trihalomethanes, a family of organic chemicals that occurs as a by-product of chlorination, the procedure used by most municipal suppliers to disinfect water. Contamination of bottled water by this chemical group isn't as problematic because most bottled water is disinfected through ozonation (the process of imbuing water with oxygen). A 1980 epidemiological study revealed higher cancer rates in cities that chlorinated water, apparently the result of trihalomethanes. Residents of such cities were found to have a 53% greater chance of contracting colon cancer and up to a 93%-higher chance of getting rectal cancer than the average resident of towns that didn't use chlorine.

Home plumbing with lead pipes or solder can poison municipal water. So get your water tested if you think you have a lead problem. If you do, new plumbing, a home filter, or a switch to bottled water will help. Federal standards limit the amount of lead in drinking water to 50 parts per billion (ppb), but the EPA is considering tightening those standards to 20 ppb. Lead, of course, is a toxic metal known to be harmful to human health if inhaled or ingested. Known effects of exposure to lead range from subtle biochemical changes at low levels, to severe neurological and toxic effects or even death at extremely high levels or in fetuses or young children.

Reports of contamination to your town water supply provide another reason to switch to bottled water. Leaking gas tanks, pesticide application, malfunctioning septic systems, acidic mine drainage, a leaking landfill, or some other source can make water unsafe. As a rule, water tends to be purer deeper down, so consider bottled water if you are served by a shallow or poorly constructed well.

Given the current state of testing and regulation, it's impossible to claim that bottled water is always safer than tap water. Likewise, there is little support for claims that bottled water, especially mineral water, provides superior health benefits. Most experts agree that minerals are better absorbed into our bodies through food. A steady diet of high-mineral-content-water could also bring too many minerals into the body. (One mineral you may *not* get enough of is fluoride, a naturally occurring preventer of tooth decay. In a recent study at the Harvard School of Dental Medicine, 11 of 12 bottled waters tested for flouride contained nowhere near the amount required to meet the EPA standard set for municipal drinking water.)

On the other hand, one 1988 study released by the California Department of Health entitled *Water Exposure and Pregnancy Outcomes* concluded that women who drank bottled water were at less risk of miscarrying or bearing babies with birth defects.

BOTTLED WATER STATE BY STATE

States that have enacted IBWA water-testing standards:

California*
Connecticut*
Florida*
Hawaii
Massachusetts
New Hampshire
New Jersey
New York*
Ohio
Oregon
Texas
Wyoming

* The standards in these states are more stringent than those of the IBWA.

Bottled water sold in the remaining states is subject to the less-stringent federal standards for tap water; any water bottled or shipped interstate is subject to FDA standards.

States in the process of adopting IBWA standards:

Arizona
Maine
Michigan

States reviewing IBWA standards:

Colorado
Delaware
Iowa
Maryland
Nevada
New Mexico
North Carolina
Oregon
Pennsylvania
Rhode Island
South Carolina
Vermont
Washington
West Virginia

GETTING TO KNOW YOUR WATER

Although bottlers are not required to specify their water type on labels, many do anyway. Here's what the terms mean:

Artesian: Refers to the water's source. Artesian water comes from a well which is drilled into a contained aquifer where water is held under pressure and doesn't have to be pumped out.

Bottled: Simply, water that is contained in a bottle or package. Bulk water provided via office coolers or home dispensers makes up a large part of the bottled-water market.

Carbonated (or sparkling): Bottled water containing carbon dioxide either naturally or as a result of injection. Even naturally carbonated water that comes out sparkling from a spring or well may go flat before bottling. In that case, bottlers may "re-introduce" carbonation by forcing pressurized carbon dioxide into water.

Distilled: Water that is boiled, then condensed, leaving behind all contaminants and minerals. Cheaper than many bottled water products and the purest available.

Drinking Water: Bottled water from an approved source that has undergone some method of filtration and ozonation.

Mineral Water: Water that contains a high mineral content. May appear cloudy. Several states require that 50 parts per million of total dissolved solids be present in water to qualify it as mineral water. In most cases mineral water comes from a spring.

Natural: Refers to bottled, spring, mineral, artesian or well water, i.e, any water coming directly from ground or surface water, not a public supply.

Spring Water: Water that flows to the surface of the earth naturally from underground. May or may not be naturally carbonated.

Well Water: Water pumped from underground via a hole bored, drilled, or otherwise tapped into an aquifer.

Seltzer and Club Soda: In both cases, filtered, artificially carbonated tap water. Club soda, however, has added sodium. Although unregulated by the FDA, some states require that these waters meet FDA or IBWA quality standards for bottled water.

• WHAT TO LOOK FOR WHEN BUYING BOTTLED WATER

No one has conducted a comparative analysis of all bottled waters sold in the United States. And because bottlers are not required to submit test results to the FDA, it is difficult to recommend one brand over another except perhaps on a regional basis. Even using state and Consumers Union studies is inconclusive, because although each brand was tested for various contaminants, bottlers didn't get a comprehensive grade. If you're buying bottled water because it tastes better than tap water, or because the water in your community may be threatening your health, you'll want to buy the best bottled brand in your area. And that means *you* have to do some investigating. Contact bottlers directly and ask some questions. Here are guidelines:

* Ask the bottler if he/she is a member of the IBWA, which maintains regulations for its members that are a bit more stringent than those imposed by the FDA. The IBWA requires its members to test for 51 contaminants. Those who want even more market credibility can apply for IBWA certification which demands that bottlers test for 129 contaminants. By 1991, the IBWA will require members to test for a total 181 contaminants. While IBWA's testing schedule is the same as that used by the EPA for checking public water supplies, Executive Director William Deal claims that most bottlers voluntarily check for the presence of identifiable contaminants more frequently. Bacteria tests, for example, are conducted daily in many cases.

The IBWA also sends a third-party inspector from the National Sanitation Foundation, a private lab, to bottling plants annually. This person inspects all pertinent records and makes sure the plant is run cleanly.

*Ask the bottler for the location of his/her source. Legally, bottled water can come from a public source. If the bottler does get water from a public utility, ask what sort of treatment processes have been used to remove bacterial contamination. You may decide to steer clear of a brand that chlorinates its water. If the source is a well, a surface stream, or a spring, ask the bottler for its specific locality. Is the area undeveloped, residential, or agricultural? Is there a high concentration of natural contaminants? Some surface waters are situated in "protected" watersheds where some or even all development activities have been prohibited or restricted.

*See if the company has a generally good testing record: Ask for a list of the contaminants they test for and compare that list to the tests required in your state or municipality.

*Try to buy bottled water in glass bottles whenever possible. So far, no study has been conducted on the effects of contamination from plastic packaging into water. But the issue was raised in California two years ago, when the California Health Services Department detected concentrations of methylene chloride ranging between four and 10 parts per billion in water that had been stored for 14 days in plastic bottles made of a polycarbonate resin. The testing revealed up to 30 parts per billion in water stored for 40 days.

If you buy water in large containers that typically use that resin, see if the label indicates the date bottled: Buy "fresh" water and store it in glass jugs when you get home.

Of course, bottled water *would* just be a fad if our public water supplies were in better shape. The EPA says it will be regulating 200 contaminants in public supplies by the year 2000, certainly an improvement over the system we have now. Bottled water will get stricter guidelines, too.

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We offer a selection of the finest quality ultra-low-flush toilets. All use only one to one-and-one half gallons per flush, yet work better than many standard toilets that use three to five gallons. They will reduce stress on wells and septic systems and can dramatically lower water and sewer costs. Installation measurements are standard.

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Reviewed by Ginia Bellafante and Hannah Holmes

Old-Fashioned, But Efficient

Modern washing machines are time-efficient, but depending on how they're used, they can guzzle up more than their fair share of water and energy. Even small loads of laundry require large amounts of water, often heated, then used once and dumped down the drain. (Heating water actually accounts for 90% of the non-labor cost of doing your laundry.)

Before you buy a fleamarket washboard, consider a tried-and-true wringer washer like the Speed Queen, developed in 1911 and still in production. The water level, controlled by a faucet, can be adjusted to any size laundry load up to 25 pounds. The washing time, too, can be tailored to each load. And the machine operates on 800 watts of electricity, as opposed to 1000 or 1200 watts used by most newer washers.

A wringer washer is even more efficient for families who wash many loads of laundry in succession. Because the hot rinse water is wrung from the clothes by motor-driven rollers mounted over the washer, the water remains in the wash bowl, ready for another load.

The Speed Queen has a safety-conscious modern add-on: An automatic spring on the wringer rollers keeps fingers from getting caught when feeding laundry into the machine. The Speed Queen is available for $495 through the Real Goods News Catalog, 3041 Guidiville Rd., Dept. GM, Ukiah, CA, 95482; 800-762-7325. For a list of other dealers, contact Speed Queen at (414) 748-3121.

Natural Pest Control

Ninety percent of American households use pesticides. That's what a 1987 study by the National Academy of Sciences concluded. Thirty percent of the pesticides available in this country are suspected cancer-causers and many others remain on the market without adequate testing. Although "natural" pesticides, like synthetic ones, should be handled with caution, most of them do pose fewer environmental risks. Pyrethrins, substances derived from chrysanthemums, are relatively non-toxic and will get rid of a wide variety of insects on flowers, shrubs, trees, and vegetables.

Pyrethrins are available under various brand names in garden centers nationwide, but many of the commercial varieties contain piperonyl butoxide, a low-toxicity chemical synergist that does not meet the approval of many organic-farm certifiers for use on organically grown produce. Harmony Farm Supply carries pyrethrins made from pure plant extract and no synergists. Use them to effectively battle wasps, beetles, caterpillars, cabbage loopers, and other common pests. Send $2 to Harmony Farm Supply, P.O. Box 451, Dept. GM, Graton, CA, 95444 for a catalog (fee can be applied to first purchase). One of the synergist-free pyrethrins they carry: Safer's Zap, available for $12.98 per pound plus $3 shipping and handling.

For more on natural pest controls see our Sept.-Oct. issue.

Greentapping Telephones

Working Assets, the San Francisco-based, socially responsible investment service, is "tapping" telephones for altruism. The firm has teamed up with U.S. Sprint, a long-distance telephone company, to raise money for environmental groups by diverting a portion of each member/customer's monthly bill into a special fund. Customers who sign with Sprint via Working Assets pay no additional costs beyond the standard charges. But one percent of each bill goes directly into the Working Assets fund. At the end of every year, members/customers vote on which environmental groups should receive donations from that fund. (Working Assets benefits because it gets a commission from Sprint for attracting new customers to the company.)

The investment group is already well known for a similar program it runs in conjunction with VISA and MasterCard. Working Assets credit-card holders generate money for a roster of non-profit groups working toward peace, human rights, and a safer environment. (See *Ask Garbage*, Sept.-Oct. 1989, for more details.)

To become a Working Assets/Sprint customer, call (800) 522-7759.

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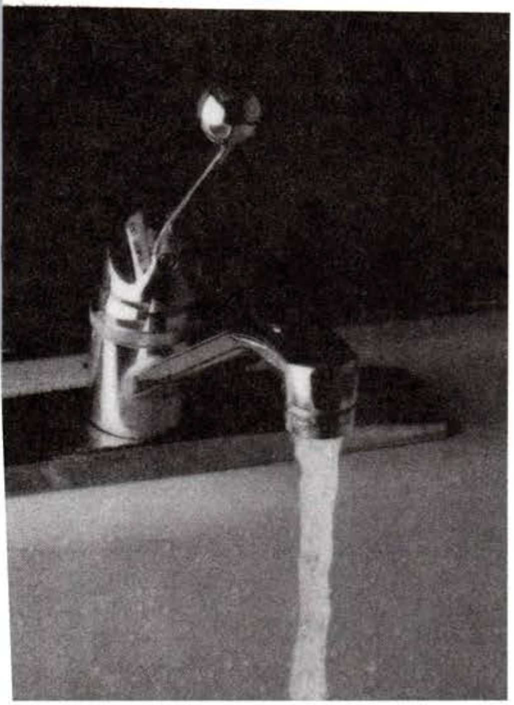


Water Filters

In some areas the phrase "pure tap water" is considered a contradiction in terms. (See *Bottled Water: Fads and Facts*, page 46). The lakes, reservoirs, springs, and wells that funnel water into municipal supplies are all vulnerable to contamination from hundreds of different chemicals. In some cases, treatment procedures used to eliminate harmful substances don't function as well as had been hoped. If your water looks, tastes, or smells a little "off"; or if you live in a community with a poor history of water-quality, consider a supplementary home filtering system. Although no system can attack all contaminants, the right system offers a longer-lasting and cheaper solution to your water problems than switching to bottled water.

The burning question, of course, is just which system is the right one. There are different filtering technologies available for different contaminant problems, a slew of manufacturers for each system type, and a wide range of prices in every category. Higher-priced models typically last longer and remove a greater quantity of the contaminants they're designed to attack. Before you purchase any sort of filter, get your water tested to find out exactly what's in it.

To make filter shopping a little easier, we've pulled together a list of moderate- and high-priced systems that use the most efficient filtering technologies available (descriptions below). All systems listed treat drinking and cooking water drawn from kitchen taps. Extremely polluted water may require a combination of systems throughout the house. When you do buy a system, make sure to speak to your dealer about maintenance costs: Most systems require frequent filter-changes.

Activated-Carbon Filtration

When water passes through an activated-carbon filter, contaminants attach themselves directly onto the carbon granules' porous surface. (Systems using granular or solid-carbon-block filters work better than those containing carbon powder.) Activated carbon filters remove most organic pollutants, including chlorinated pesticides and many volatile organic hydrocarbons. Activated carbon filters are the most efficient in removing toxic chemicals most often found in water. However, nitrates, some metals, particulates, radioactive materials, and dissolved solids may still end up in your water. Our favorites:

Pollenex Pure Water 99, fits on tap, available at K-Mart, Walgreen, and Sears, or call (800) 621-0786 for a dealer in your area. Price: $29.

The Hurley II, countertop model. Call (312) 388-9222 for a dealer in your area. Price: $360.

Distillation

Distillers heat water until it vaporizes and then rinse or flush out bacteria and suspended matter from that vapor. The purified steam is then collected, cooled, and condensed into pure water. Even the minerals are removed, and that may make water taste bland. Our favorites:

Kenmore 3455, a countertop model, available at Sears nationwide. Price: $99.49.

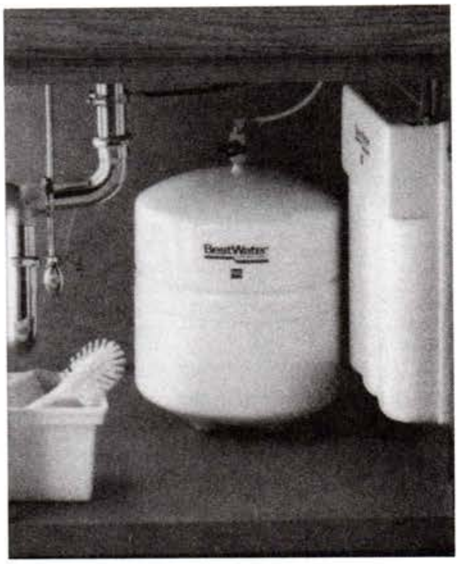
Durastill 46A, a countertop model available through mail-order from Durastill of New York, Inc., 375 Great Neck Road, Dept. GM, Great Neck, NY 11021. For more information and shipping and handling charges, call (516) 829-6034. Price: $349.

Reverse Osmosis (RO)

These systems can remove up to 99% of water's impurities by forcing water (via tap) through a semi-permeable membrane that lets water pass through while rejecting most components dissolved in it. RO systems will remove organic contaminants such as pesticides and other chemicals, as well as inorganics such as metals and nitrates, most particulates, radioactive materials, and dissolved solids. Our favorites:

The Kenmore Standard 3497, under-sink model. Different systems are designed for chlorinated and non-chlorinated water and priced at $367 and $397 at Sears nationwide.

Best Water by Shaklee, under-sink model. Call (800) 345-5366 for a dealer in your area. Price: $675.



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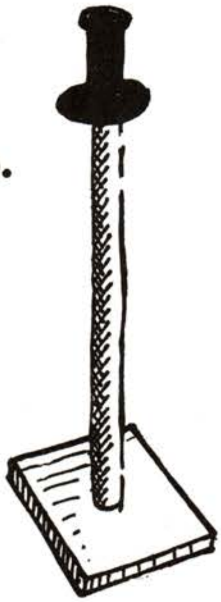

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Cleaner Shampoo

Most shampoos contain preservatives typically derived from petrochemicals and formaldehyde. These chemicals are included to kill off bacteria that feed on organic ingredients; and that can irritate the skin and eyes of human beings. Some bacteria also emit gasses that can cause shampoo bottles to explode on store shelves. However, the preservatives can induce harmful health effects similar to those caused by bacteria. Furthermore, synthetic preservatives don't break down easily in sewage treatment plants, and can contaminate the sludge or wastewater that the plants produce.

Tom's of Maine keeps bacteria under control using no synthetic preservatives at all. Tom's shampoos (Aloe and Almond for adults; Honeysuckle for babies) are preserved with citric acid and contain no artificial dyes or animal ingredients. The cleansing agents used in Tom's shampoos are derived from coconut oil rather than a chemical substitute. Tom's shampoos are available at health food stores nationwide, and at some supermarkets. Retail prices range from $3.75 to $5.50 for 12 ounces.

Carcinogen-Free Coffee Filters

If you're worried about reports of dioxin residues in bleached-paper coffee filters, you have two new options. Dioxins are chemicals suspected of causing cancer and birth defects in human beings. They are a by-product from bleaching paper pulp with chlorine. U.S. Environmental Protection Agency research shows that dioxin leaches out of the paper when hot water is poured over it.

To avoid the health risk, switch to unbleached coffee filters, or a reusable gold-plated mesh filter. Natural Brew makes unbleached, brown filters that are reportedly more durable than the bleached-white variety.

Two hundred #8 basket-style filters cost $3.25. Eighty #2, #4, or #6 cone filters are $3.95. Natural brew filters can be ordered through the Seventh Generation Catalog, 10 Farrell Street, Dept. GM, South Burlington, VT 05403; (802) 862-2999.

The other solution, elegant in more ways than one, is the gold-plated filter that a few coffee-maker companies offer. Braun Inc.'s 23-carat gold-plated filter lasts for years, and is available at specialty and major department stores nationwide for about $20.

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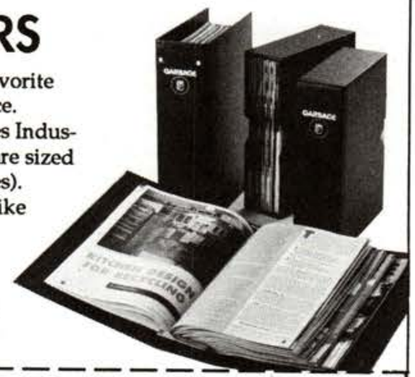

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Buzzworm
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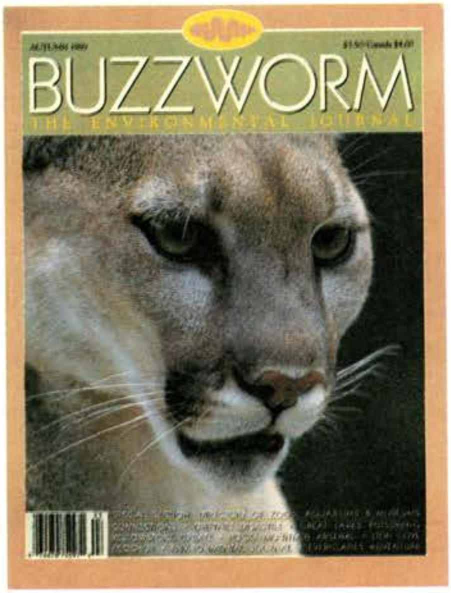
Bimonthly magazine published by Buzzworm, Inc., 1818 16th Street, Boulder, CO 80302. Subscription: one year (6 issues) $18.



Laid up with the flu last week, I got to actually read some of the magazines I subscribe to. About a dozen paragraphs into a story about the Great Lakes, I started to cry.

A tearjerker wouldn't have done that to me, even mellowed as I was with fever. No, this was clean, expository writing. The article was well crafted and it hit me hard. I cried tears of frustration at the short-sighted, selfish, clumsy mess we've made.

I was reading *Buzzworm* (the magazine's title comes from an old Western word for rattlesnake). Built around founder Joseph E. Daniel's collection of breathtaking photographs, the journal covers wildlife, habitats, environmentalists, and controversy. Feature articles are comprehensive and the writing is very good. The photos are stupendous.

Both his magazine and ours have gotten a lot of attention lately. Interviewers ask me, "What about *Buzzworm*?" Apples and oranges, I say. No, scratch that: more like yin and yang. *Buzzworm* has a giraffe on the cover; **GARBAGE**, a trashcan. *Buzzworm* talks more about animals, **GARBAGE**, more about people. *Buzzworm* is beautiful; **GARBAGE** is useful. *Buzzworm* may elicit tears of joy, rage, or discontent. **GARBAGE** may offend you or make you laugh.

It occurred to me that day in bed that **GARBAGE** is *Buzzworm*'s prosaic cousin. *Buzzworm*, there to remind us of what we have and what we may lose, is the love behind the concept of home. **GARBAGE**, there to do the chores, has dishpan hands. Sure, the editor in me looks longingly at *Buzzworm*'s sumptuous paper and gorgeous color photos. But no use fighting it, I'm the prosaic type. I'm glad *Buzzworm* is there to inspire me.

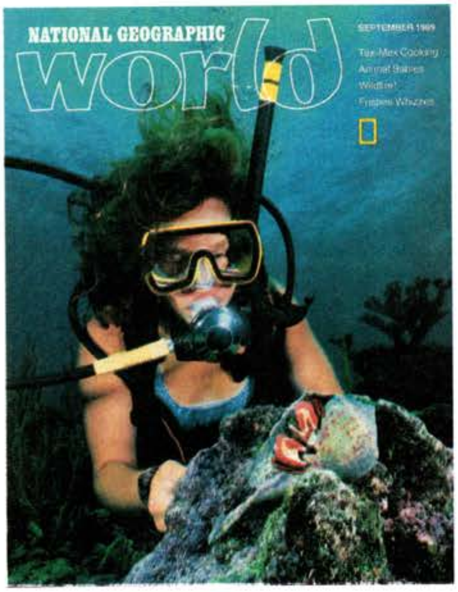
Tell you what, Joe: You keep the home fire burning, and I'll, uh ... take out the garbage.

— *Patricia Poore*

Environmental Magazines for Children

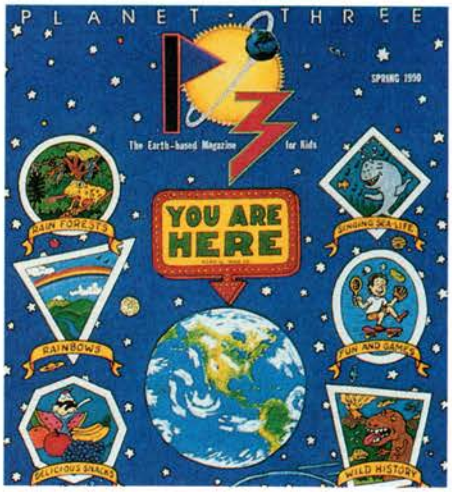
World

Monthly magazine published by the National Geographic Society, P.O. Box 2330, Washington, D.C. 20077-9955. Subscription: One year: (12 issues) $10.95



P3: The Earth Based Magazine for Kids

Published 10 times a year by the P3 Foundation, P.O. Box 52, Montgomery, VT 05470. One year: (10 issues) $14



Ranger Rick

Monthly magazine published by the National Wildlife Federation, available only to members of Ranger Rick's Nature Club, 1400 Sixteenth Street, N.W., Washington D.C. 20036-2266.
Annual dues: $14.

There's an old Kenyan proverb that goes something like this: treat the earth well; it was not given to you by your parents, it was lent to you by your children. Unfortunately, generations past did not heed this wise advice. As a result, children will inherit a planet that is, quite frankly, a mess. Global warming, overpopulation, and ever-mounting garbage heaps are problems that our children will face tomorrow.

If you want your kids to start becoming environmentally aware *now*, hand them one of these on-target, educational publications. Children as young as six years old can enjoy these magazines because they are filled with photographs and lively graphics. Older kids will enjoy the simply written but informative articles. We think they'll get hooked.

The National Wildlife Federation, publisher of *Ranger Rick*, has been educating the public on conservation and nature for the past 50 years. *Ranger Rick*, now in its 23rd year, continues this mission for children 7-12 years old. The magazine is devoted almost exclusively to wildlife coverage. Recent issues included an article on an outdoor school called Expedition Yellowstone, an interview with Boomer Badger, a bat scientist, which was followed by an exposition on various bat species, and a story on giant pandas in China.

The National Geographic Society was founded over 100 years ago to increase and diffuse knowledge of geography. For 15 years, *World* has extended that goal to include children 8-12 years old. *World* is an eclectic magazine, covering a much broader array of topics than *Ranger Rick*. Classic wildlife photographs and accompanying articles compose about half the magazine; the other half is devoted to historical, technological, and general-interest stories. This year the magazine plans to devote articles specifically to environmental topics such as endangered species, food and population, acid rain, energy, and solid waste. The April issue will cover the twentieth anniversary of Earth Day.

The newest addition to children's environmental magazines is also the most different. It is published by the non-profit P3 Foundation, whose goal is to educate children about the environment. Members of the organization include a host of scientists, lawyers, environmentalists, teachers, and students. *P3* stands for planet three, or the third planet from the sun — the fragile and beautiful planet Earth. The magazine, which is printed on recycled paper, is for children 6-12 years old.

The first issue includes a study of oil — from the Exxon Valdez spill in Alaska to the uses of oil in everyday objects. The editors, who have worked at such major children's magazines as *Electric Company* magazine, *The Big Picture*, and *Muppet Magazine*, say they would like to "empower children to act." This philosophy is reflected subtly in stories like "Max and his Mom," in which the character Max convinces his mother to ride a bicycle rather than drive her car to work.

The magazine also empowers children by encouraging letter writing. One article about elephants and ivory includes the addresses of President Bush, the Prime Minister of Japan, and the United Nations Environment Programme.

— *Bruno Tedeschi*

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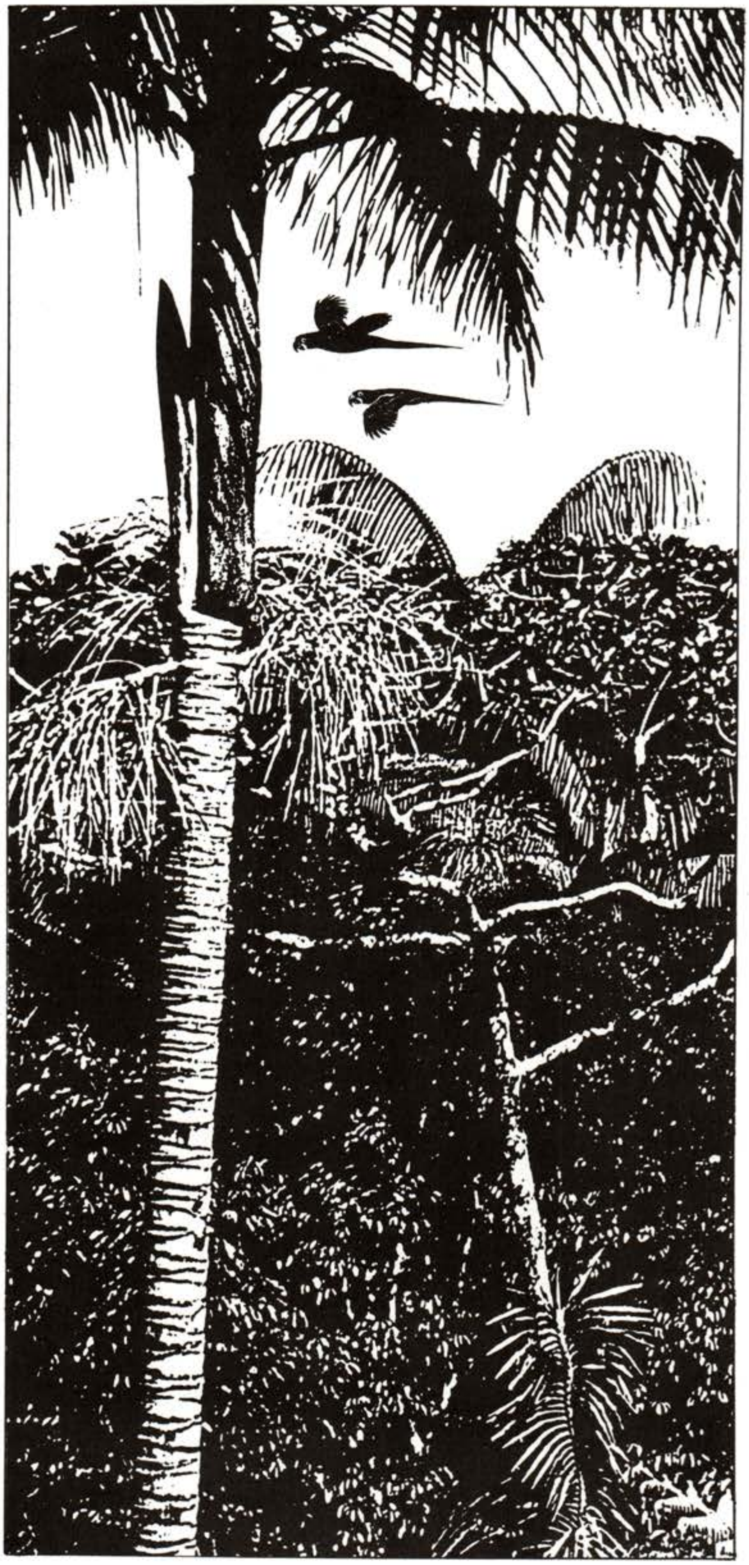

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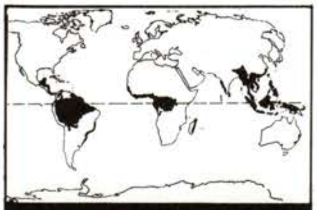

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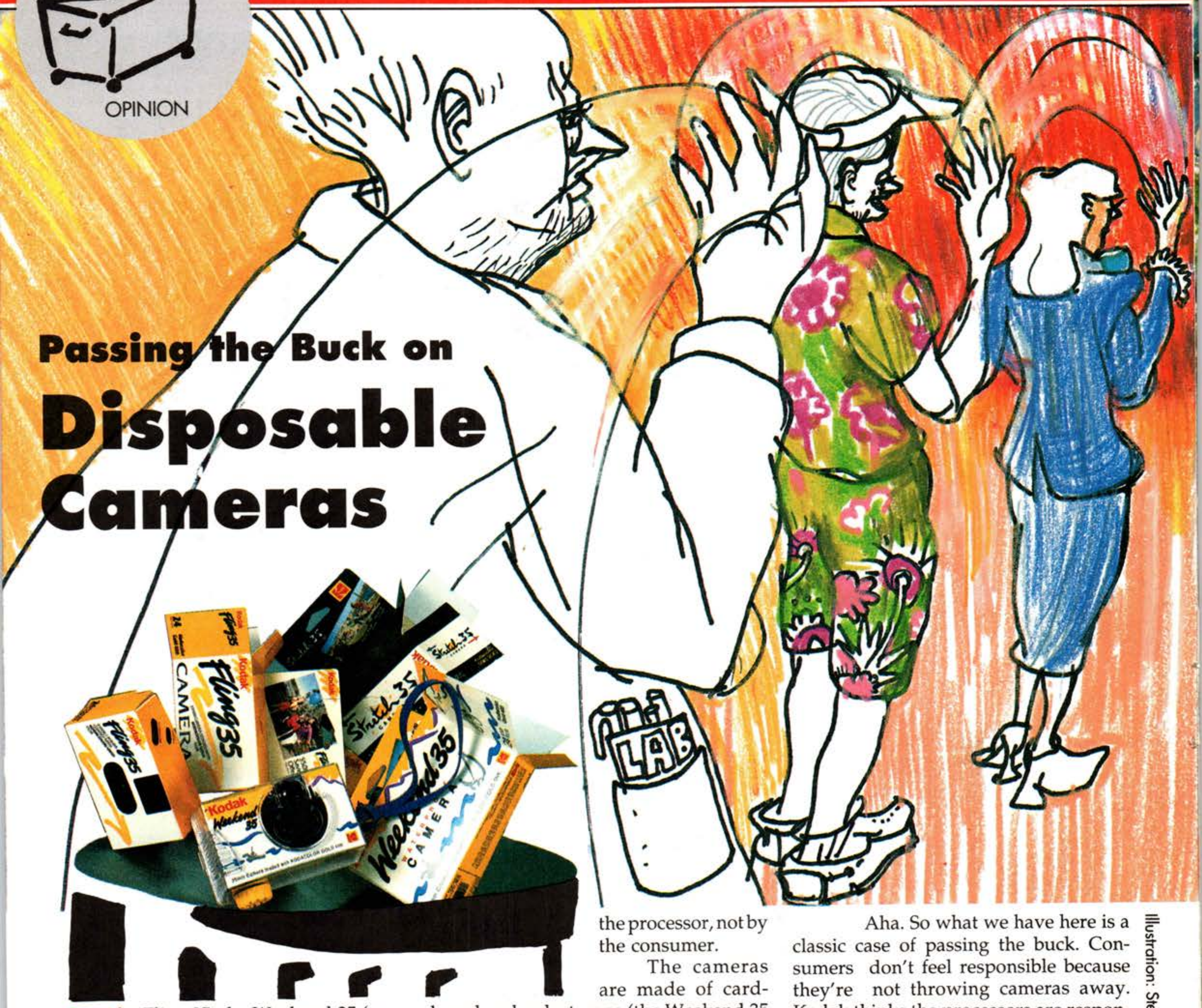


Illustration: Stephen Moros

Photo: Donald Betts/Horizon Photographics, Inc.

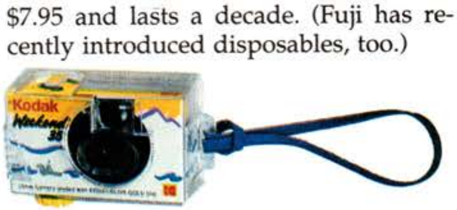
The Fling 35, the Weekend 35 (waterproof) and the Stretch 35 (wide-angle lens) – these are three new cameras from Kodak. They range in price from $6.95 to $13.50 and each is preloaded with a roll of 24-exposure film. Here's the hitch: Once the single roll of film is shot, the camera is delivered intact to a developer, where the film is developed and the camera body is tossed.

Ironically, Kodak is aware that "disposable" is becoming an unpalatable term in the marketplace. Company spokespeople correct reporters who refer to the camera as a disposable or throw-away, avidly encouraging that we say "single-use" instead. Spokespeople also claim that "disposable" doesn't apply, because the camera is thrown away by the processor, not by the consumer.

The cameras are made of cardboard and polystyrene (the Weekend 35 has an additional layer of PETG copolyester). We all know the cameras don't just disappear. Kodak agrees that they shouldn't go into trash cans, but the company doesn't have plans to recycle them. Kodak believes the responsibility for proper disposal (which they don't define) or recycling of cameras lies with the photo processor. Theoretically, the polystyrene bodies could be recycled once the Plexiglass lenses were removed, but such recycling facilities number at less than a handful right now. In an informal survey of 13 New York City area photo developers, we found that only one sent camera bodies to a recycler even though there is a polystyrene recycling facility in Brooklyn.

Aha. So what we have here is a classic case of passing the buck. Consumers don't feel responsible because they're not throwing cameras away. Kodak thinks the processors are responsible. In the midst of all the argument, these gadgets are heading for our landfills.

And what do we need a throw-away camera for, anyway? It's not more convenient; either way you have to remember to take a camera along. It's not better; if you want good pictures and control of a shot, you bring your Nikon. It's not cheaper; a lightweight tried-and-true instamatic — from Kodak — costs $7.95 and lasts a decade. (Fuji has recently introduced disposables, too.)



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RESTORATION

The Hambleton Island project site before execution in February, 1972.

An aerial view of the wetland construction area in 1976.

Wetlands – bogs, marshes, and swamps – are crucial natural resources. Waterfowl and other wildlife depend on them for food and habitat. They serve as spawning grounds for food fish. Wetlands filter pollutants and mitigate erosion. But decades of channel dredging, tunnel and bridge construction, shoreline bulkheading and other sorts of development have destroyed many of these vital lands.

Eighteen years ago, Edgar Garbisch had an idea. The Maryland-based marsh ecologist wanted to undo some of the damage – so he undertook a pioneering program at his own expense. With a team of scientists and workers, Mr. Garbisch took on the restoration of Hambleton Island, a narrow 15-acre marshland in the Chesapeake Bay, which had been rapidly eroding.

Mr. Garbisch used both artificial and natural processes to rebuild the ecosystem and attract biological organisms to the tidal marine environment once again. Workers unloaded 600 truckloads of terrestrial quarry sand adjacent to the island, creating a two-acre man-made sand flat. They also cultivated 60,000 seedlings in greenhouses using synthetic sea water, and planted them on the new plot. Nine species of hardy marsh plants evolved. In fact, tropical storm Agnes, which took its toll on the Chesapeake area in June of 1972, barely affected the young marsh.

Within eight months after the project was initiated, animals inhabiting the artificial sand flat were discovered to be identical to those found in natural control areas. More than 12 species of microflora covered the sand flat, and beneficial insects and insect larvae abounded. Canadian geese, muskrats, and deer, once indigenous to the island, all grazed there again.

Dubbed "a Wright Brothers flight in the world of wetland ecology" by the American Bureau of Shipping, Hambleton Island was a phenomenal success. It has been the prototype for other tidal-marshland restoration projects since.

Edgar Garbisch founded and directs Environmental Concern, Inc., a research facility specializing in wetlands. Since 1971, the firm has constructed and/or restored 300 wetlands along the mid-Atlantic coast. *– Ginia Bellafante*

Photos courtesy of Environmental Concern, Inc.